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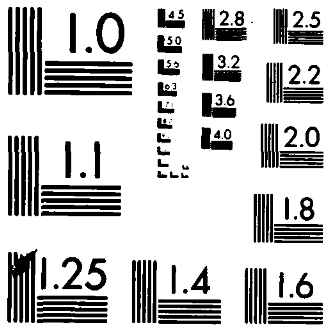
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CPESIM II: A COMPUTER SYSTEM SIMULATION FOR COMPUTER PERFORMANCE EVALUATION USE

THESIS

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Captain, USAF

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DEPARTMENT OF THE AIR FORCE
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Wright-Patterson Air Force Base, Ohio

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Presented to the Faculty of the School of Engineering
of the Air Force nstitute of Technology
Air University
In Partial Fulfillment of the
Requirements for the Degree of
Master of Science

David L. Owen, B.S.
Captain, USA

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Preface

Professor Thomas Hartrum provided the original stimulus for this thesis. While teaching computer performance evaluation courses, he discovered a need for a vehicle to illustrate the problems and techniques he was discussing in class. In 1979, Capt Paul Lewis wrote a simulation to help solve some of these problems. As time past, limitations in the original simulation needed to be solve.

This thesis is the first step in converting the standalone simulation package into a total computer performance evaluation simulation environment. This environment should include as a minimum a simulated computer, "user" interfaces, data base record keeping, and workload generators. My attempt was to redesign and code the simulated computer system, and create a "user" interface to the system. From this basic environment follow on efforts can then enhance the environment in a modular fashion.

I would like to thank Professor Hartrum for his guidance and valuable suggestions that he made through out the development of this thesis. Lt Col Clark proved to be not only a excellent committee member, but a source of knowledge on many obscure aspects of SLAM. Finally, I wish to thank my future wife Sue for her understanding and support on those many nights when I had to work.

David L. Owen

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Abstract

This report describes the development of an education tool which is used in conjunction with a course in computer performance evaluation. The tool is a system composed of background information and software which simulates a computer system. The student is assigned a position in a fictional computer site, and is given performance problems to solve. The instructor prepares scenarios, constructs a model of the site's workload, and describes the initial computer configuration. The student takes this information and uses it to decide if additional data is required from the hardware and software monitors.

The student forms an improvement hypothesis and makes changes to the simulated computer site. Changes to the simulated computer configuration are made by an interactive "user" interface. The configuration changes, along with the workload description and monitor requests are submitted to the simulation. The simulation uses these inputs to simulate a large mainframe computer with attached software and hardware monitors. Accounting and monitor logs are generated by the simulation. After examining the outputs, the student provides further changes until he is satisfied with the simulated computer site's performance.

This document provides a copy of the current software used to imitate the computer, the software used to generate the "user" interface, and instructions to the instructor and the student on executing the software on the ASD computer systems which support AFIT.

CPESIM II: A Computer System Simulation for Computer Performance Evaluation Use

I. Introduction

Background

Every computer system eventually comes to the point where more computing power is needed. In the past, the general solution has often been to buy more hardware without analyzing the performance of the present computer system. Recently, more and more effort has been placed on analyzing the computer environment as a whole to determine if additional resources are needed or if the computer can be "tuned" to perform more efficiently. In a study for the Air Force (Ref 6), Bell, Boehm and Watson suggested seven phases for a Computer Performance Evaluation (CPE) team to follow to successfully evaluate the computer system and its environment (Figure 1). In order for a student to effectively learn the CPE tools, he should gain experience in using these seven phases. The first four phases, understanding the system, analyzing operations, formulating performance improvement modifications, and analyzing probable cost-effectiveness of modifications, can be accomplished with information provided by the instructor. The instructor can either use an actual scenario or can make

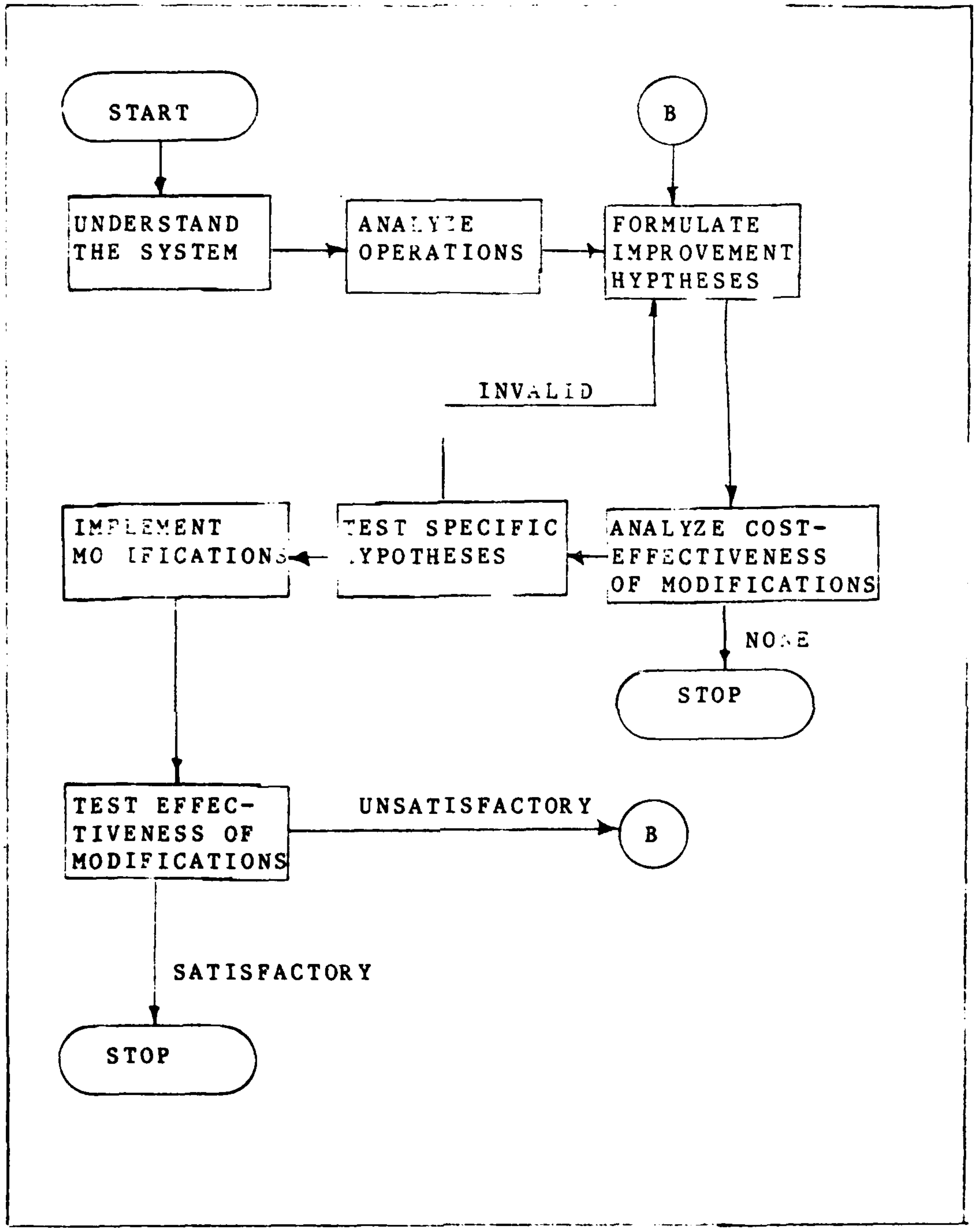

Fig. 1 Performance Improvement (Ref 6)

up a scenario to illustrate a particular performance problem. In order for the student to accomplish the last three phases, testing specific hypotheses, implementing appropriate combinations of modifications, and testing the effectiveness of the implemented modifications, the student must have access to CPE data from an actual or simulated computer system. CPE data comes from three general sources: accounting data, software monitor data, and hardware monitor data Many computer installations have only some of the data necessary, and even that may not be adequate. In addition, many installations cannot afford to have students experiment with their operational system. In order for the students to gain "hands on" experience in the last three phases, a computer simulation is needed. In 1979, Capt Paul Lewis developed a model (called CPESIM II) to aid students in performing CPE (Ref 7).

Problem Description

While Capt Lewis' model was a major step in aiding the CPE student with "hands on" experience, it had several shortcomings. The first major shortcoming is similar to many real life computer environments. The software monitor for CPESIM II did not provide the necessary information for the student to successfully analyze the problem. The second problem with CPESIM II was the language in which it was written. CPESIM II was written in SIMSCRIPT II (Ref 3), which at the time was one of the better simulation languages. Since 1979, the expertise for SIMSCRIPT has not been available at AFIT and it is no longer being taught. The final problem with CPESIM II was with the user interface. The amount of work required to run the simulation was burdensome to both the instructor and the student. Thus, an easy means of obtaining all the necessary CPE data was still needed.

Approach

One possible approach to solving this problem was to modify the existing CPESIM II and to create a "friendly" user interface. There are several problems with this approach. First, since SIMSCRIPT is no longer taught at AFIT there is a question about how much longer it will be supported. Secondly, even if the desired enhancements were made, the possiblity of incorporating future improvements is small since the students do not understand the language. Finally, more powerful simulation languages have been developed since the original CPESIM II was written.

Since more powerful simulation languages are now in existance, it seems reasonable that the one of these languages should be used to develop the new CPESIM II. The choosing of the proper simulation language to implement both the hardware and the software CPESIM II will be discussed in greater detail in later chapters. With this new model the student will get a better environment to enhance his skills in the world of CPE. He will have an easier to understand and more realistic model of a real computer environment. In addition, the instructor can concentrate more on developing realistic scenarios and less time on changing the model to fit these scenarios.

Scope

As with any simulation, certain limitations have to be placed on CPESIM II. The number of possible architectures and operating systems i almost limitless. In order to get a model of reasonable size which ill take a reasonable amount of time to execute, a spec fic architecture and operating system was chosen. In particular, the architecture will consist of a classic von Neumann machine, which can vary in memory size, allocated and unallocated I/O devices, I/O channels, and number of CPUs. The operating system will be a static partion memory, multiprocessing operating system. In addition there will be a specific software and hardware monitor for the computer system. Interactive processing, distributed processing, and dynamic memory allocation will not be covered in this thesis.

The financial cost and manpower required to use the monitors, to buy more hardware, o to manipulate the computer environment is not addressed. This is a necessary part of CPE, and should be supplied in the instructor scenario given to the students.

Order of Presentation

Chapter II describes the system's requirements for CPESIM II. Chapter III describes the transformation of the requirements into the system design. Chapter IV describes the results and validation of CPESIM II, while Chapter V provides a final summary and recommendation for future enhancements. Appendix A provides a detailed representation of the requirements in SADT form. Appendices B and C provide the detailed design in SLAM network form and Structured English, respectfully. Appendix D lists the actual CPESIM II code. Appendix E consists of an instructor's manual for using the simulation, while Appendix F is the student's CPESIM II manual.

II. System Requirements

Environment

CPESIM II is intended to be used in graduate level computer performance evaluation classes and graduate level queueing theory classes. These classes concentrate on the application of modern tools and techniques for evaluating a computer in its environment. Specific techniques are presented throughout the term and the student is given case studies to which these techniques are applied.

CPESIM II's high level requirement is to give the student a "realistic" system in which he can apply these techniques to the given case studies. In order to successfully integrate the case study with CPESIM II, the instructor needs to develop a scenario which will demonstrate the performance problems. The scenario will consist of describing the computer, its environment, and possibly its performance problem or desired goal. The description could be in prose form or in the form of accounting and monitor data of an existing system. The student will evaluate the given data and determine if he has enough data to formulate an improvement hypothesis. If more data is required, then he can run the CPESIM II model to get accounting data, software monitor data or hardware monitor data. Once sufficient data is available he will form a hypothesis that might solve the problem. The student will then implement his hypothesis by changing the computer configuration of the CPESIM II model and run the model against the workload. The model shall provide "realistic" accounting data, and depending on the request, hardware and software monitor data. The student will analyze the data and determine if other changes are needed. If necessary this process can continue until the student is satisfied with his solution to the original problem. Figure 2 shows this case study flow in SADT (Ref 1) format.

Software Requirements

The software implementing CPESIM II shall provide a "realistic" computer environment to the student. In order to provide this "realistic" environment, the software will be broken into four parts.

The first portion of software will produce a workload data file which may be used as input to the simulation. The instructor will input the different types of job streams in terms of empirical distributions. The program will take these distributions and calculate job streams. The job streams will consist of job parameters such as job name, cpu time required, number of disk I/Os, etc. Each job will then have its parameters written to the workload data file in a format that the computer simulation can use.

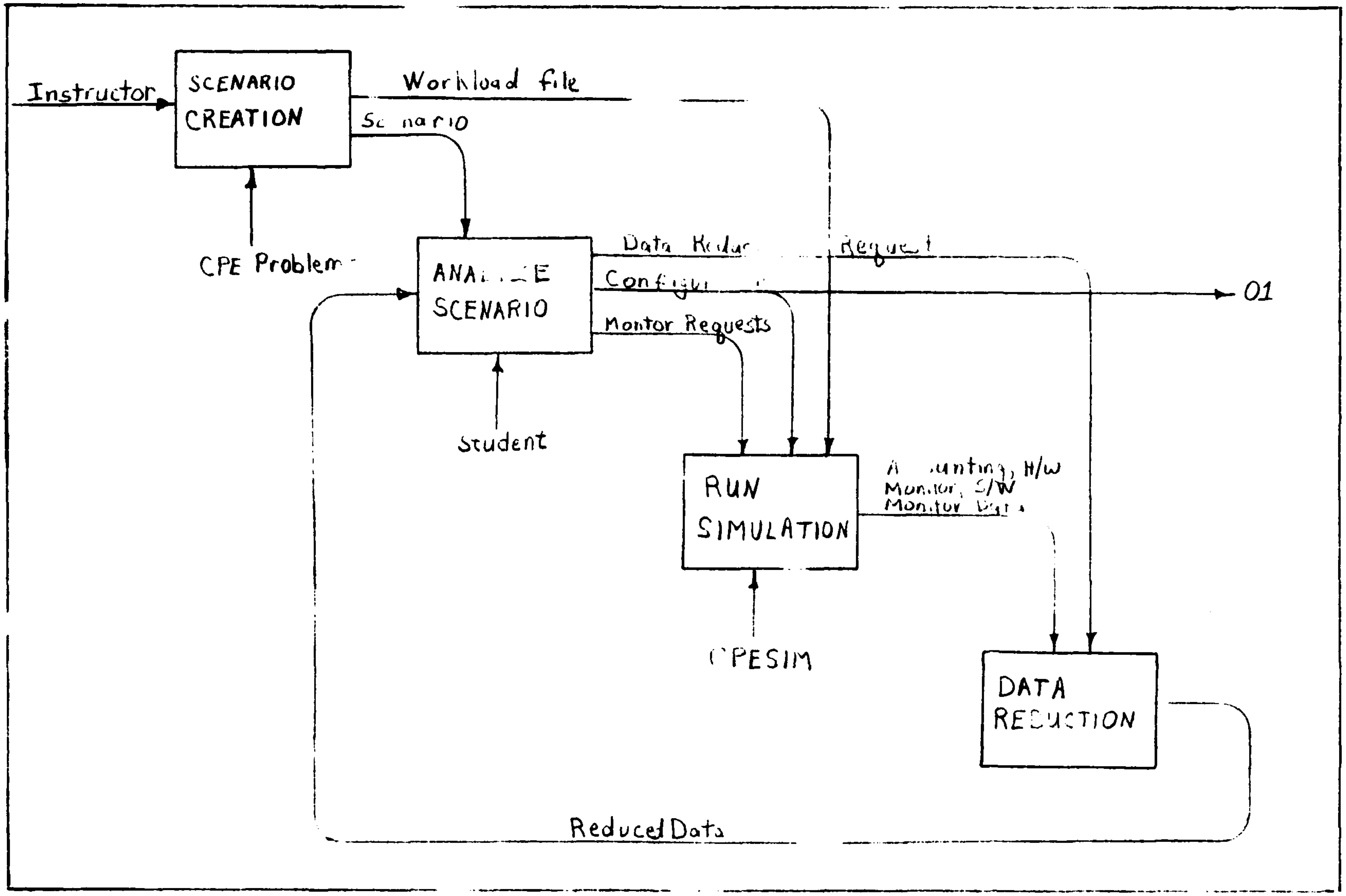

Fig 2. Case Study Flow

The second portion of CPESIM II will be the user's interface to set up of the computer's architecture and operating system. In this portion of code the specific computer configuration must be specified. The software must be able to describe the hardware configuration in terms of number and speed of cpus, I/O devices, and channels; size of main memory; and hardware monitor connection probes. In addition, the I/O matrix between the channels and the I/O devices has to be described. The user interface will also be able to specify the start and stop times for the software monitor and hardware monitor.

The third part of CPESIM II will be the post processing of the accounting data file, the software monitor data file and the hardware monitor data file. The processing will produce listings which will be similar in format to real accounting, software monitor and hardware monitor output files. This processing will not affect the original data file. This will allow the students to analyze the raw output using standard statistical software packages like Statistical Package for the Social Sciences (SPSS) (Ref 9).

The last software portion of CPESIM II will be the simulation of the computer and operating system. The architecture will vary slightly according to the the user's input parameters, but the basic machine will be the classic von Neumann computer (Ref 5). It will consist of one or more cpus, main memory, I/O channels, allocated I/O devices (tapes, card readers and line printers), and unallocatable I/O devices (disks, drums) (Figure 3). The operating system is a basic multiprocessing, multiprogramming, partioned memory operating system (Ref 8). Looking at the hardware and the operating system as a combined unit, a typical job will perform six basic tasks as it flows through the simulation (Figure 4). At job arrival the job will be spooled (1) onto disk. After spooling the job will be placed into the hold queue where it will wait for the job scheduler to allocate resources (2). After the resources are allocated the job will wait in the execute queue. When a cpu becomes free the cpu will perform a cpu burst (3) on the job. After the cpu burst one of three things will happen. If the job is not finished the job will either go back into the execute queue or perform an I/O (4). If the job is completed it will be placed in the output queue until it can be spooled to the printer (5). The last process (6) is the writing of the data files and the freeing of the job's resources.

In addition to the hardware and the operating system the last software portion will contain both the hardware and the software monitors. The hardware monitor will be an event driven monitor which will record timing and counter data for the cpus, channels and I/O devices. The hardware monitor will not affect the (simulated) speed of the cpu.

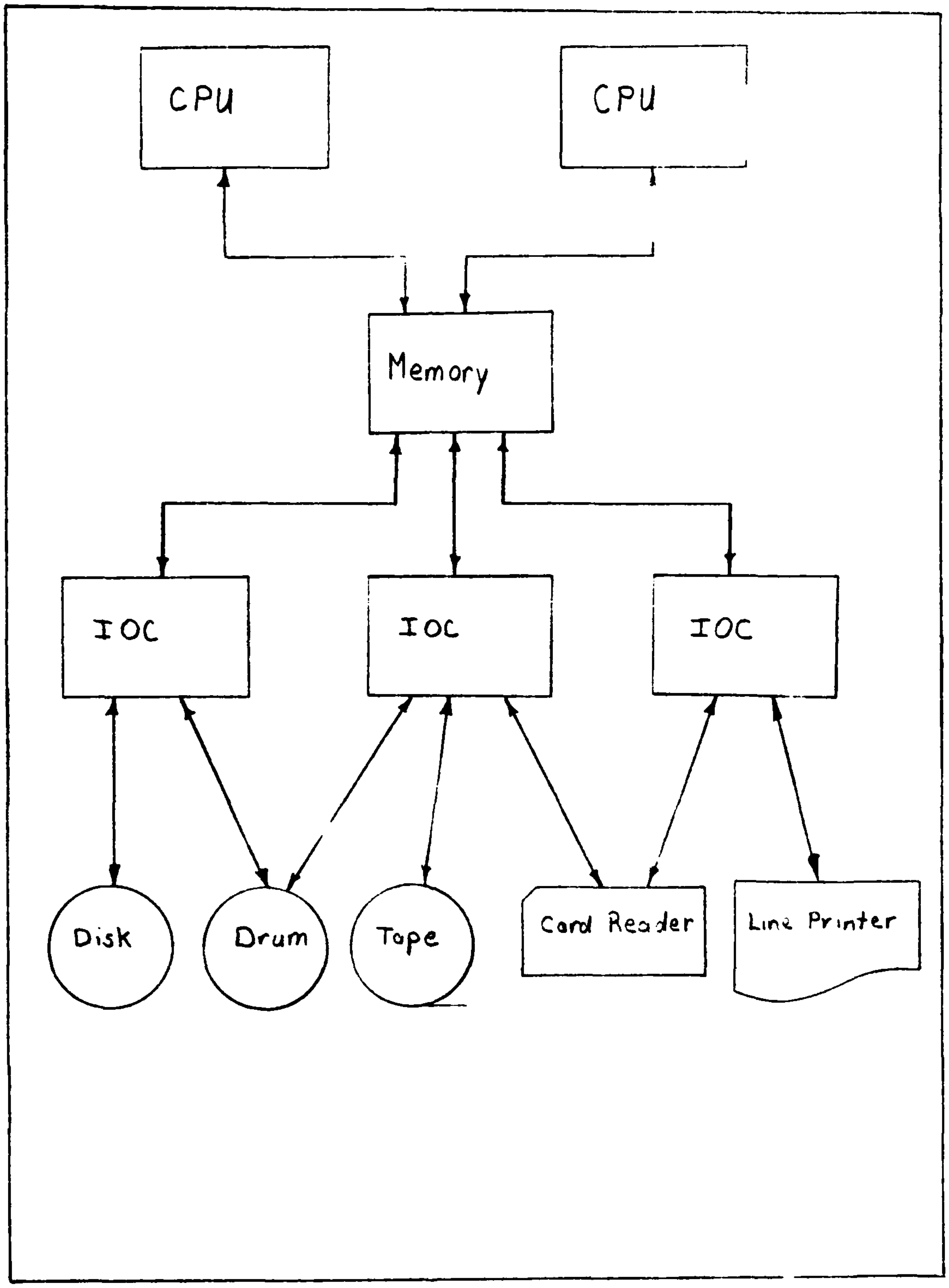

Fig 3. Typical CPESIM II Configuration

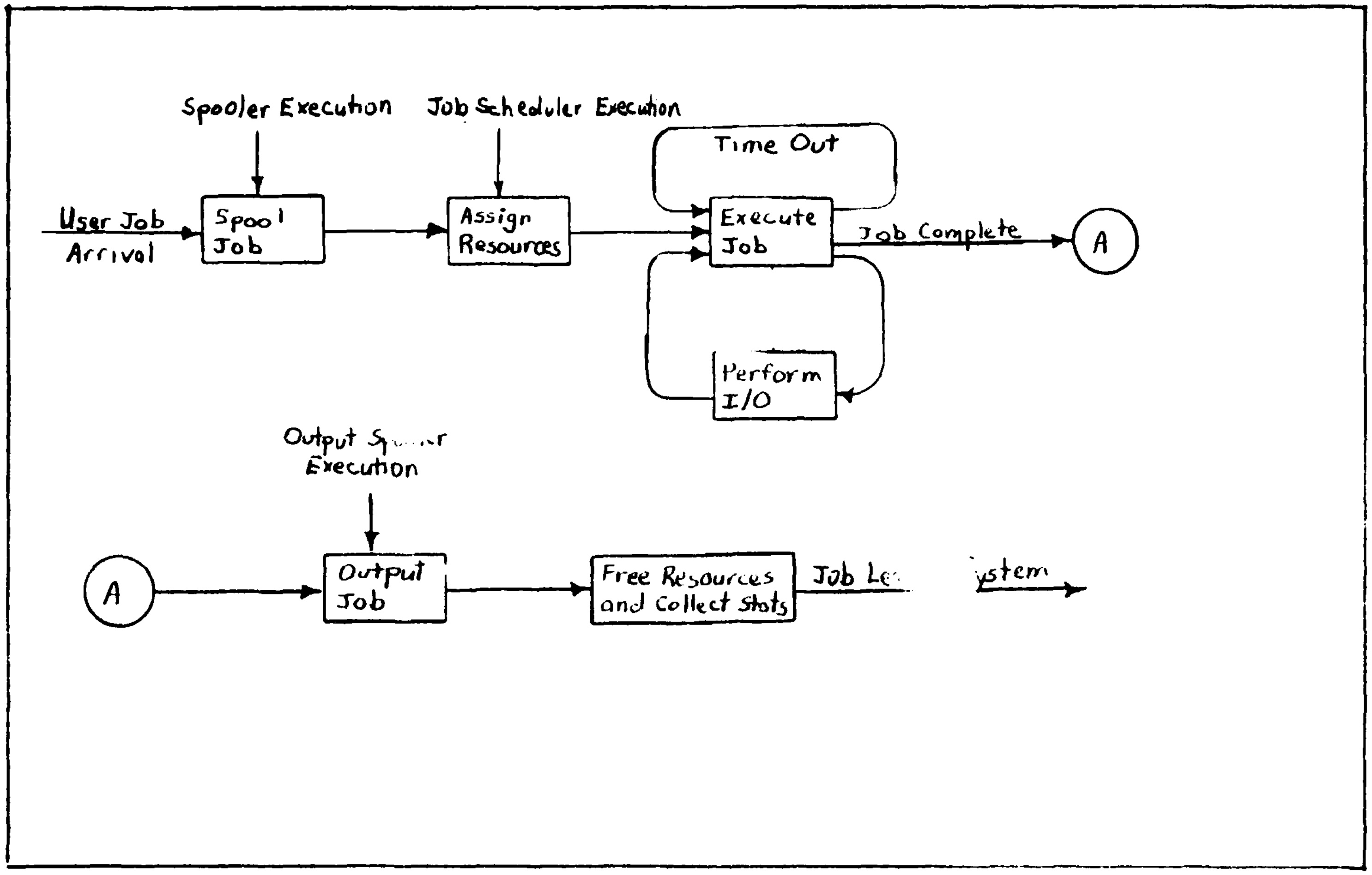

Fig 4. Job Flow

The software monitor will keep track of the time that a job spends in each of the queues. Unlike the hardware monitor, the software monitor will slow down the relative speed of the simulated cpu. This slowdown represents the increased overhead which a real software monitor causes on a real system.

Appendix A contains the detailed requirements of the simulation in SADT form.

Support Requirements

CPESIM II is only one portion of an educational tool in teaching CPE. There is more to CPE than just applying tools in a "closed" system. With enough money and equipment almost anyone can improve the performance of a computer. To effectively learn all the aspects of CPE, the student needs to be presented with a scenario which represent a "total" computer environment. Scenarios will aid the student in learning the complexities involved in the decision making process. The scenario should include data on the present hardware and software configurations, possible limitations in configurations, and costs associated with the different pieces of equipment. In addition to the measurable factors in the system, intangibles like the user's and management's needs and goals should be represented. With a scenario the simulation will be more than a simple "plug and chug" exercise.

Support is also needed for the student to analyze the results of the simulation run. After the student has implemented his improvement hypothesis, he needs to analyze the affects on the system. In order to do this, he needs access to standard statistical packages like SPSS (Ref 9).

Conflicting Requirements

There are a few conflicts with the requirements for CPESIM II. Like any simulation, the conflicts involve flexibility and complexity of the simulation. An increase in flexiblity directly correlates to an increase in complexity. There are an infinite number of computer configurations which are available. In order to get a "reasonable" simulation, limitations must be made in the flexiblity of the system. This "reasonable" simulation must be flexible enough to effectively teach the tools of CPE while simple enough for the student to comprehend the simulation and for the developer to implement it.

Verification and Validation

The verification of CPESIM II will test the accuracy of the model to execute the statements in the proper order. This will be done by running a workload of a few programs through the model. These programs will cause the execution of all the statements in the model. A visual inspection will be made to insure that the model executes the statements as expected.

How does one validate a simulation that is not a model of anything in real life? That is the problem one has to address when trying to validate `PESIM II. CPESIM II is a representation of a "computer" in the general sense, but not of any parti-ular model. It should behave like a typical computer given a certain workloac, but it should not produce exactly the same results. For that reason, it cannot be directly compared to any real life data from a computer system. Thus, the validation by comparing it to a real life machine will have to be intuitive in nature.

The new CPESIM II should act similar to the old version of CPESIM II, but once again the matching will not be exact. The new version has enhancements, particularly in the job scheduler algorithm and the I/O scheduler algorithm, which the original CPESIM II did not have. As a result of these enhancements, the output data of the simulations should have some correlation for the same workload, but not an exact correlation.

Summary

This chapter has presented only the high level requirements for PESIM II and a general verification and validation procedure. If the reader is interested in the detailed requirements needed to design and test the simulation, he should now read Appendix A before going on to the next chapter which will cover the design of CPESIM II.

III. Simulation Design

This chapter discusses the thought process and decisions that were made in the design and development of the CPESIM II simulation software. In particular, this chapter will discuss the simulation language chosen, the design of the simulated computer architecture, operating system, workload parameters, user interface, and post processing software.

Implementation Languages

In order to decide on which language or languages would be best to use, certain criteria had to be established. First, the language must be presently supported by one of AFIT's computers, and should have a high likelihood of future support. Secondly, the language should be user friendly. The users should not have to know all the details of simulation but only about those portions which effect the performance of a computer. The third criteria that a language was gauged against was that of its power. The power of a language shall be defined as the ability of the language to handle the mundane bookkeeping associated with simulations, with little or no user intervention. At the same time the language should give the programmer the ability to go to a lower level if desired.

The original CPESIM II was written in SIMSCRIPT II so Simscript was a natural benchmark against which to judge other languages. In 1979, AFIT supported SIMSCRIPT II and it was one of the more powerful languages. By 1983, more powerful languages had come into being. AFIT is no longer teaching SIMSCRIPT II and most of the expertise at AFIT has been lost. It was questionable whether or not it would be supported in the future. SLAM (Ref 10) on the other hand, is well supported by AFIT and is one of the most powerful languages of the day. The support of SLAM and its power make it a very desirable language, but SLAM is not user friendly. In order to overcome this drawback, a second language was introduced to make a user friendly interface. This interface will use FORTRAN V (refs 2, 3) to modify the configuration data file which initializes the simulation to a particular hardware configuration. This interface shall query the user about the different options available and then generate a configuration data file. Thus the power of SLAM can be used to program the simulation and the user can still have a user friendly system.

Computer Architecture

After the simulation language was decided upon, the type of computer architecture to be simulated had to be established. There were two main types of architectures considered. The bus oriented architecture, which is representative of many of the mini computers, has a central bus which links the cpu, the memory and the I/O devices together. The central-memory architecture uses main memory as the interface between the cpu and the I/O devices. The central-memory architecture was chosen for two reasons. First of all, it is representative of the majority of the large scale computers in which CPE would be used and secondly, it is the architecture which proved itself as a valuable teaching aid in the original CPESIM II.

There are many possible varieties of central-memory computers. The CPESIM II design is a trade off between flexiblity of the different varieties and a reasonable sized simulation. Most of the limits on the simulation were based on having a reasonable simulation (in terms of size and speed). Since SLAM was written in FORTRAN, the basic memory allocation for a SLAM program is the same as a FORTRAN program. This memory allocation requires that the size of arrays be specified at compile time. Unlike PASCAL and some of the newer languages, these arrays are initialized at run time and use a fixed amount of memory during the entire simulation. For this reason, dimensions of arrays were carefully chosen. The number of channels, allocatable I/O devices, unallocatable devices, and memory partitions had to be analyzed. The simulation can easily be expanded if desired by changing the limits on these arrays.

The basic computer consists of a single cpu multiprocessing system. Because the cpu is treated as a server by the SLAM compiler, multiple cpu configurations are available, but the hardware monitor will treat all the cpus as one. There will still be one execute queue in the multiple cpu configuration. When a cpu is free, the cpu will get the first job in the execute queue and will perform a time burst on that job. There is no limit on the number of cpus that the simulated computer can handle.

A static partition memory management system is implemented in the simulated computer. There is a maximum of twenty partitions available to the user. Twenty partitions should be a sufficient number of partitions so that the student can tailor the size of the partitions to fit several different workload streams, the input spooler, output spooler and software monitor. There is no limit on the size of the memory partitions. The implementation of a dynamic memory management scheme was investigated. Based upon experience with the original CPESIM II, dynamic memory management took excessive amounts of real cpu time to execute the simulation. For this reason, it was determined that the simulated computer would not have dynamic memory management.

The IOCs connect the I/O devices to memory. There is a limit of five IOCs connected to memory. The limit on the IOCs was based on past experience with CPESIM II. Performance problems such like having all the high-speed devices on one channel, or just a general backlog for an IOC can be modeled with just one or two IOCs. The IOCs can have any data transfer rate desired and be multiplexed to any or all I/O devices. This combination will allow the instructor to create a scenario for just about any I/O performance problem.

The I/O devices are broken into four types. The first type is the card reader. There is only one card reader. The card reader is only used by the input spooler, and can be connect to any or all channels. The card reader can be set to any desired speed (cards per minute). Presently the simulation assumes that the card contains 80 bytes of information. This could be changed by changing one variable in subroutine INTLC. The choice for only one card reader was to simplify the algorithm for the input spooler. Adding the capablity of having multiple card readers does not substantially add to teaching of CPE.

The second type of I/O device is the line printer. Like the card reader, there is only one line printer, and it can be connect to any IOC. The line printer prints a 132 character line at any desired speed (lines per minute).

The allocatable I/O devices (tapes) are the third type of I/O devices. Allocatable devices are assigned to a job prior to the job being placed in the execute queue and released back to the system when the job is placed in the output queue. The I/O requests on allocated devices are spread evenly between the devices allocated to the job. The allocatable I/O devices can be set to any desired speed and be connected to any IOC. There is a limit of ten allocatable devices in any one simulation.

The last type of I/O device is the unallocatable device. These devices are usually disks or drums. The unallocatable devices are assigned to a job when a job requests a unallocatable I/O and released back to the system when that particular I/O is finished. Unallocatable device I/Os are distributed evenly between all unallocatable devices in a round robin fashion. Like the other devices, unallocated I/O devices can be specified at any speed and connected to any or all channels. There is a limit of ten unallocatable devices at one time (Figure 5).

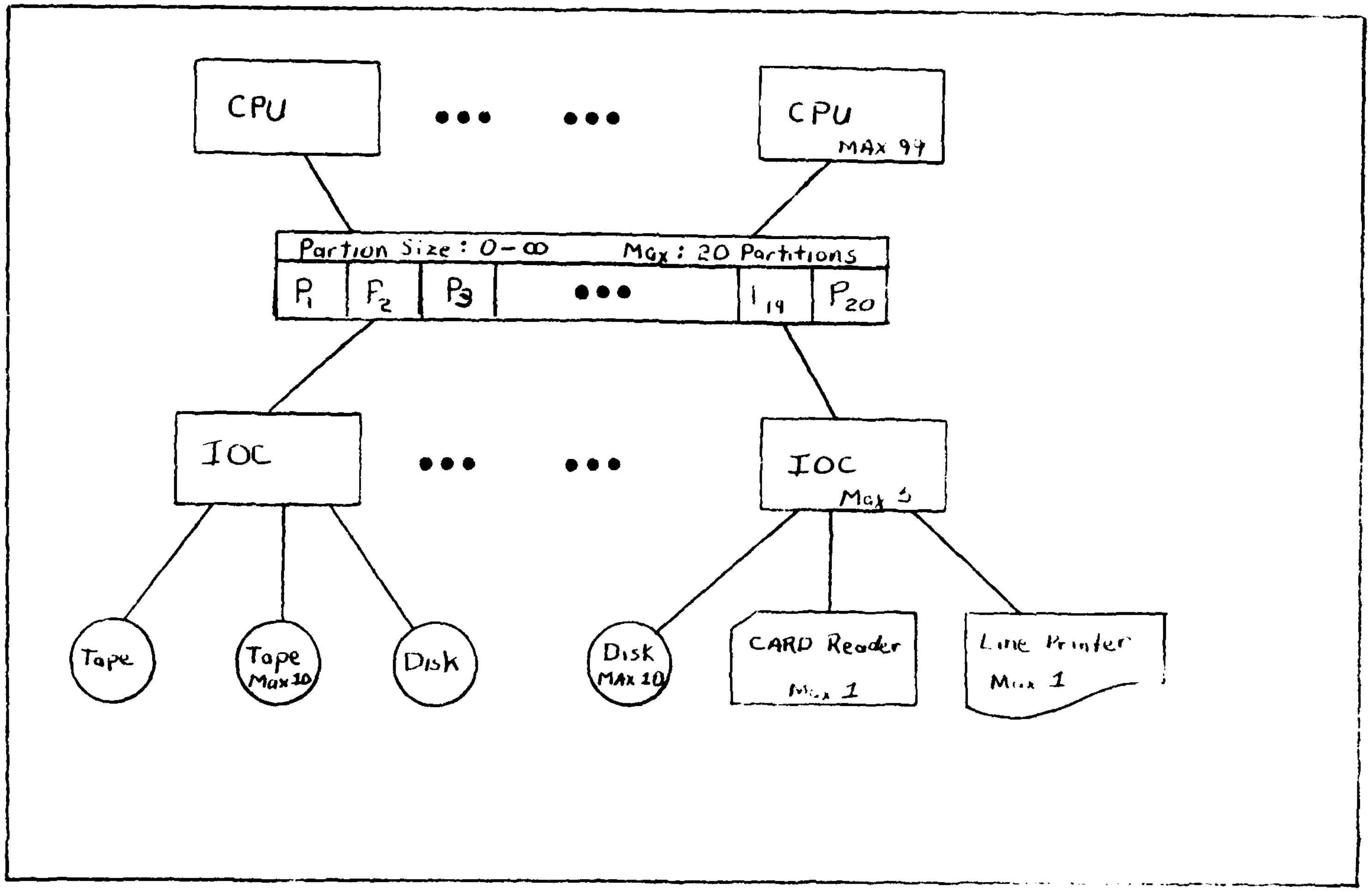

Fig 5. CPESIM II Configuration Limits

Operating System

The operacing system for CPESIM II is a multiprogrammed static partition operating system. The operating system executes five different types of jobs. The first ty,e is a typical applications program. The other four types of jobs are actual parts of the operating system: the input spooler, the output spooler, the job scheduler and a software monitor.

A typical application program gets into the system through the input spooler (Fig re 6). After the job is spooled it is placed into the hold queue to await resources. The job scheduler exami es the jobs in the hold queue, according to the job priorities and the time the job entered the hold queue, and allocates memory partitions and allocatable I/O devices to each job. After the job is allocated it proceeds to the execute queue. When the cpu is free it takes the highest ranking job in the execute queue and performs a cpu burst. Job ranking in the execute queue is done by job type. The job scheduler gets the highest priority, followed y the software monitor start-up job, output spooler, input spooler and user jobs, respectively. The cpu burst lasts until one of four things happen: an I/O was issued for an allocatable I/O device, an I/O was requested issued for an unallocatable device, a timeout occurred, or the job finishes. If an allocatable device I/O request occurred then the job gets placed in the smallest

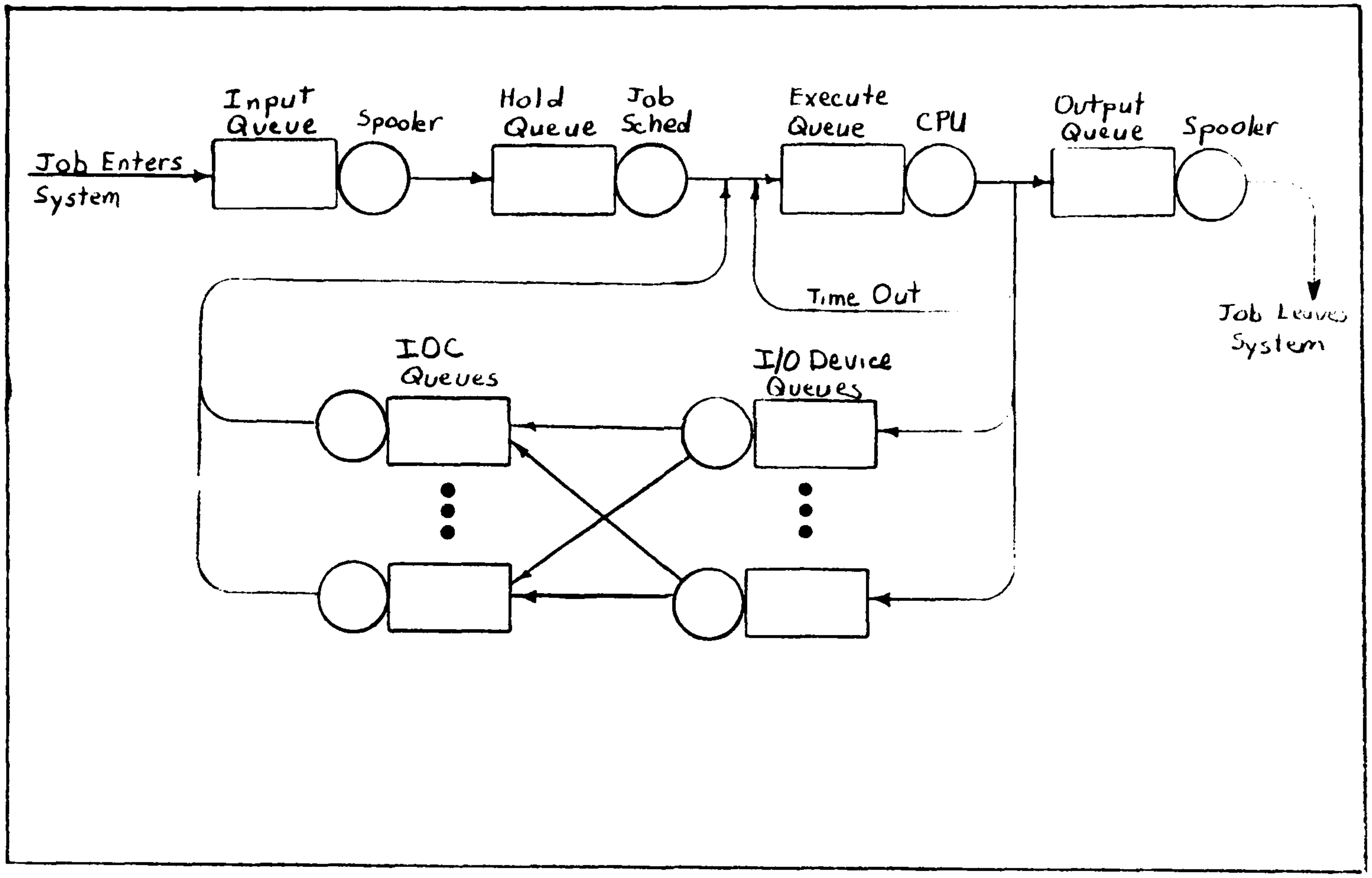

Fig 6. CPESIM II Job Flow

channel queue which is connected to the requested I/O device. The I/O is performed, the channel is freed, and the job is placed back into the execute queue. If an unallocatable device I/O occurred the job gets placed in the proper device queue. Once the device has been acquired, the job is placed in the smallest channel queue which is connected to the device. The I/O is then performed. After completion of the I/O the channel and the deviced are freed and the job is placed back into the execute queue. If a timeout occurred then the job is placed back into the execute queue to wait for another time slice. If the job is completed the job is placed in the output queue and waits for the output spooler to print the job. Also at that time, the memory partition used and the allocatable devices assigned to the job are released back to the operating system.

The input spooler takes the applications programs in the input queue (card reader) and spools them onto the disk. When a new job arrives at the input queue the operating system checks to see if the input spooler is already in memory. If the spooler is not in memory it is placed in the hold queue and must compete for resources and cpu time like any other job. When the input spooler acquires the cpu, it first schedules an I/O to read the cards into a system buffer. Presently, the system buffer is 1K, but it can be changed to any size by modifying subroutine INTLC. After the buffer is loaded the spooler is placed back into the execute queue. The next time the spooler gets the cpu the buffer is spooled to the disk. This two step process continues until the entire job is spooled. At that time the operating system checks to see if there are any more jobs in the input queue. The input spooler continues until all the jobs in the input queue are spooled. The input spooler is then released from the system and the memory partition is returned to the operating system.

The output spooler takes the job's output file which is stored on disk and prints it. Whenever a job arrives at the output queue, the operating system checks to see if the output spooler is loaded. If necessary the output spooler will be placed in the hold queue and will compete for resources. When the output spooler first executes it will perform an I/O which will load the 1K system buffer from the disk file. The spooler will be placed back into the execute queue so that it can print the buffer on the next time through. The process continues until the entire job has been printed. Like the input spooler, the output spooler continues to spool until its associated queue is empty.

The job scheduler allocates memory partitions and allocatable I/O devices to jobs in the hold queue. The job scheduler is loaded in the execute queue (if it is not already) every time a new job arrives in the hold queue or when resources are freed (after each applications job, spooler or software monitor completion). The job scheduler is always core resident as part of the operating system and does not count against the multiprogramming level. When the job scheduler obtains the cpu, it looks at every job in the hold queue to see if it can assign resources. Resources are assigned to jobs according to a priority system. The job scheduler ranks the jobs according to the job's priority attribute. This attribute is part of the job's input parameters, which are read in from the workload data file. If there is a tie, the jobs are arranged according to the hold queue arrival time. Each job in the hold queue is analyzed according to this priority scheme. The job scheduler first checks to see if a memory partition is free which can handle the job. If a memory partition is free the scheduler thens checks to see if there are enough allocatable I/O devices free. Only if both conditions are met, the job is assigned resources and is taken from the hold queue and placed into the execute queue.

Software Monitor

The software monitor is like any other job in the simulated system. It is entered into the system and must compete for computer resources. The monitor is loaded into the hold queue at the user specified starting time. It sits in the hold queue until a partition of at least 4K is available. It is then placed in the execute queue until it can acquire the cpu. When the monitor acquires the cpu it starts the tracing of jobs through five user specified queues. The software monitor then releases the cpu back to the operating system. Once the trace has started the monitor will record data about every job that enters one of the five queues. The queue name, the time spent in the queue, where the job came from, and where the job is going, is recorded every time a job leaves a queue. Like a real software monitor the monitoring of the queues and the recording of the data puts an extra burden on the system. This burden is represented by making the cpu run at 95% efficiency. When the scheduled stopping time of the monitor occurs, the memory partition is freed and the cpu goes back to running at full efficiency.

Hardware Monitor

Unlike the software monitor, th hardware monitor does not use up the simulated computer resources. The hardware monitor has its own timers, counters, and data recording devices. It is an event driven monitor which can be connected to any I/O device, channel, or cpu. The hardware monitor has two timer probes and three counter probes. These probes along with the starting time, the stopping time, and the sample data rate are specified in the configuration file. One limitation in the hardware monitor is that the monitor treats mulitple cpus as one if it was one cpu. The timer or counter connected to the cpus will be pulsed every time any cpu is activated. The output of the hardware monitor is written to a data file which is available for post processing.

Workload Generation

The software necessary for the generation of the workload data came from the original CPESIM developed by Capt Lewis (Ref 7). No changes to workload generator were made.

User Interface

In order to easily change the configuration of the simulated computer, a user interface was written in FORTRAN V. This interface allowes the user to specify the number and types of cpus, allocatable I/O devices, unallocatable devices, and channels. In addition, the connections between the I/O devices and the channels, and the number and size of memory partitions are specified. If the user desires the software monitor and/or the hardware monitor, they will be specified in this interface as well.

The interface was broken down into three sections (Figure 7). The first part of the interface takes an input file called TYPES and reads in the different types of cpus, I/O devices and channels that the student may pick from. The second part queries the student about the simulated computer configuration desired. The program does this by

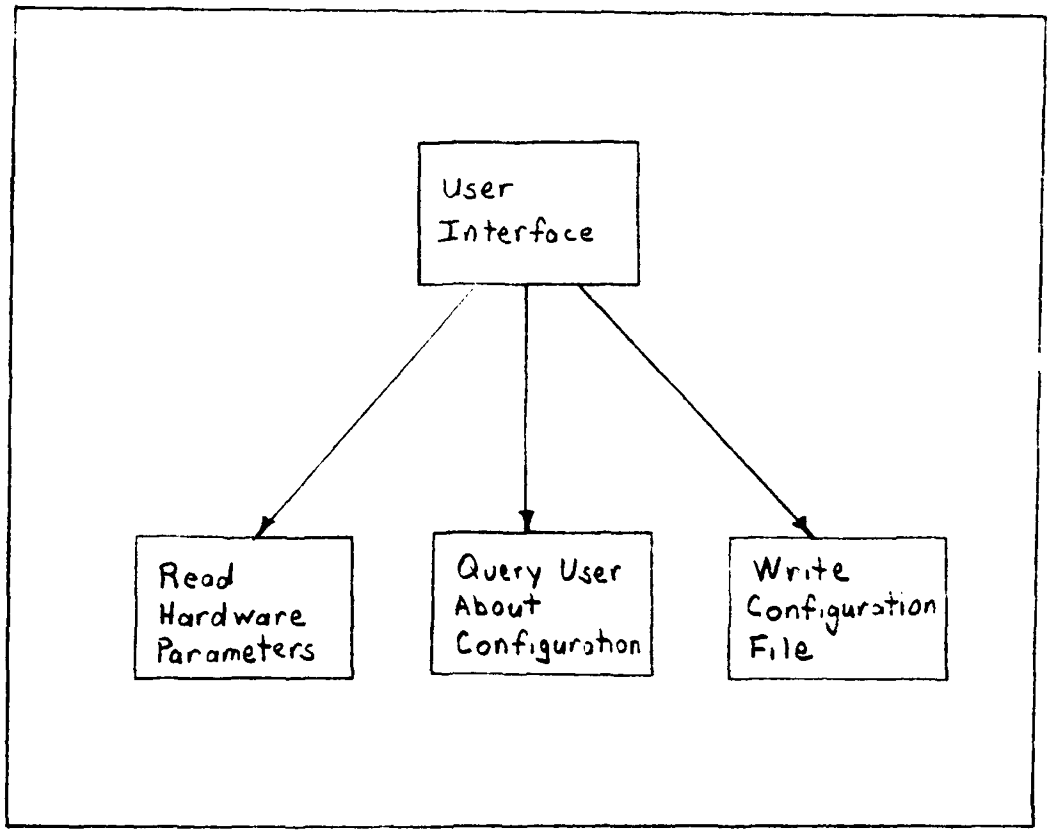

Fig 7. User Interface Structure

displaying a menu of options for each piece of equipment and allowing the user to make his choice. This section of code also queries the user about the monitors and their parameters. The third section of code takes the user's responses and writes a configuration file, called CONFIG, which can be read by the simulated computer.

IV. Verification and Validation

This chapter will discuss the method in which CPESIM II was tested and the process that occurred in validating the model. The chapter is broken into two main sections. The first section will cover the testing that was performed to verify that the code was executing as expected. The second section will discuss the validation process that occurred in validating the new CPESIM II against the old CPESIM II.

Verification

The testing of the computer simulation followed the top down implementation of simulation progra . The coding of CPESIM II was broken into five parts and the testing of the program followed these five phases.

Main Program Flow. The first phase concentrated on the testing of the "main" job flow through the computer simulation. The "main" flow consisted of job arrival, input queue, hold queue, execute queue, and output queue. There was not any I/O implemented in this phase and the monitors were not operational. Reading job arrivals from the disk, figuring cpu bursts, writing output to disk files, and general job flow were the major test objectives demonstrated in this phase.

Disk I/O and Channel Implementation. The second phase took the "main" job flow and added unallocatable I/O devices (disks) and channels to the network. The main test objective of this phase was the proper selection of devices and channels for given I/O conditions.

Tape I/O Implementation. The third phase was the implementation of allocatable I/O devices (tapes) into the network. The allocation of the devices in the job scheduler module was tested, as well as how the tape drives interacted with the channels and disk drives.

Software Monitor Implementation. The fourth phase was the implementation of the software monitor into the network. Key factors which were tested are the increase cpu time required because of the software monitor and the writing of the job's queue times to the appropriate disk file.

Hardware Monitor Implementation. The fifth phase implemented the hardware monitor network. Key factors which were tested in this phase were the counters and timers for the cpu, I/O devices and the channels.

Validation

CPESIM II validation had to be general in nature. CPESIM II represents a computer in the "general" sense. It is not a model of any particular computer and can not be directly compared to one. The simulation should behave like anyother computer in that changes in the workload and configuration of the system should have an affect on the turnaround time. In additio , CPESIM II could not be directly compared to CPESIM for two reasons. First, the alogorithms used in CPESIM II are different than the algorithms used in CPESIM. Secondly, because of a SLAM limitation on the Cyber, only about 50 jobs could be handled by the simulation. Fifty jobs was not sufficient to perform a detail validation of the syste .

V. Summary and Recommendations

Summary

This thesis provides a simulation which aids in the teaching of CPE to graduate students. The simulation, along with instructor provided scenarios, gives the student "hands on" experience in analyzing and solving performance problems in a computer center.

The simulation models a central memory architecture which has multiple processors, continuous memory, I/O channels, allocatable I/O devices, and unallocatable I/O devices. The operating system is a basic multiprocessing, multiprogramming, partioned memory operating system. The user is allowed to modify the configuration of the basic system by changing the input configuration file. The configuration file, along with a workload data file, is needed to execute the simulation. The output of each simulation run will consist of accounting data, and if requested, monitor data. If the monitors are used, the user has the choice of a software monitor and/or hardware monitor. The software monitor records the length of time a job spends in the queues. The software monitor requires computer resources like any other job. The hardware monitor is an event driven monitor which can track timer and counter data of the cpus, I/O devices and channels. Unlike the software monitor, the hardware monitor does not compete for computer resources.

The simulation does not implement interactive processing, computer networking or dynamic memory allocation. These limitations were imposed upon the simulation because of the lack of time. These limitations can be resolved in follow-on efforts, but at the present time the simulation simulates the arrival of jobs by a card reader and the printing of jobs by a single line printer.

Recommendations

CPESIM II was designed to be the nucleus of a tool to teach CPE. Several enhancements to both the simulation and its environment are are readily apparent. The following enhancements could be made to the simulation software:

1. Most of today's large computer systems are interactive in nature. The problems associated with an interactive system cannot be addressed with the present system, so the adding of remote terminals is a logical extension to the model.

2. Another area of improvement is in the world of networking or distributive processing. With the advent of minicomputers and microcomputers, more and more networks have appeared. It is likely that the students will be involved with networks and it would be beneficial if they could study the problems associated with networks.

3. During the development of the simulation, simplifications of a real computer system had to be made. One of the major simplifications that was made was that I/O requests were evenly distributed throughout the execution of a job. It is unlikely that a job's I/Os are evenly distributed. The clustering affect of I/Os could easily be implemented by changing the subroutine "USER".

In addition to the improvements that could be made in the simulation, the following are logical extensions to the front and back end of the simulation:

1. The generation of the workload data still uses the original workload generation program (ref 7). This program can only generate one job stream at a time and it is a problem to generate a multiple job stream workload data file. The ability to easily generate multiple job streams and changing the program from SIMSCRIPT II to SLAM is a logical extension.

2. The post processing of the accounting, software monitor and hardware monitor data files also needs to be written.

3. The tracking of the changes that a student makes to the simulated environment is presently a manual task by the instructor. A database which would track the changes to the configuration would greatly benefit the instructor. In addition this data base could assess charges to the student for using different pieces of equipment and making changes

to the system. By adding this change the student would have incentive to carefully analyze the problem prior to making changes.

A final recommendation would be to do a careful time and space analysis. Typical of most simulations, CPESIM II takes up a large amount of computer time and space. A typical simulation run of 50 jobs with an average simulated cpu time of 150 seconds and 1000 I/Os takes about 400 Cyber seconds. Because of the time and space required, a careful analysis of the time and space required by different simulated configurations and workloads should be done when SLAM is modified to handle more than 50 jobs at one time.

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Appendix A

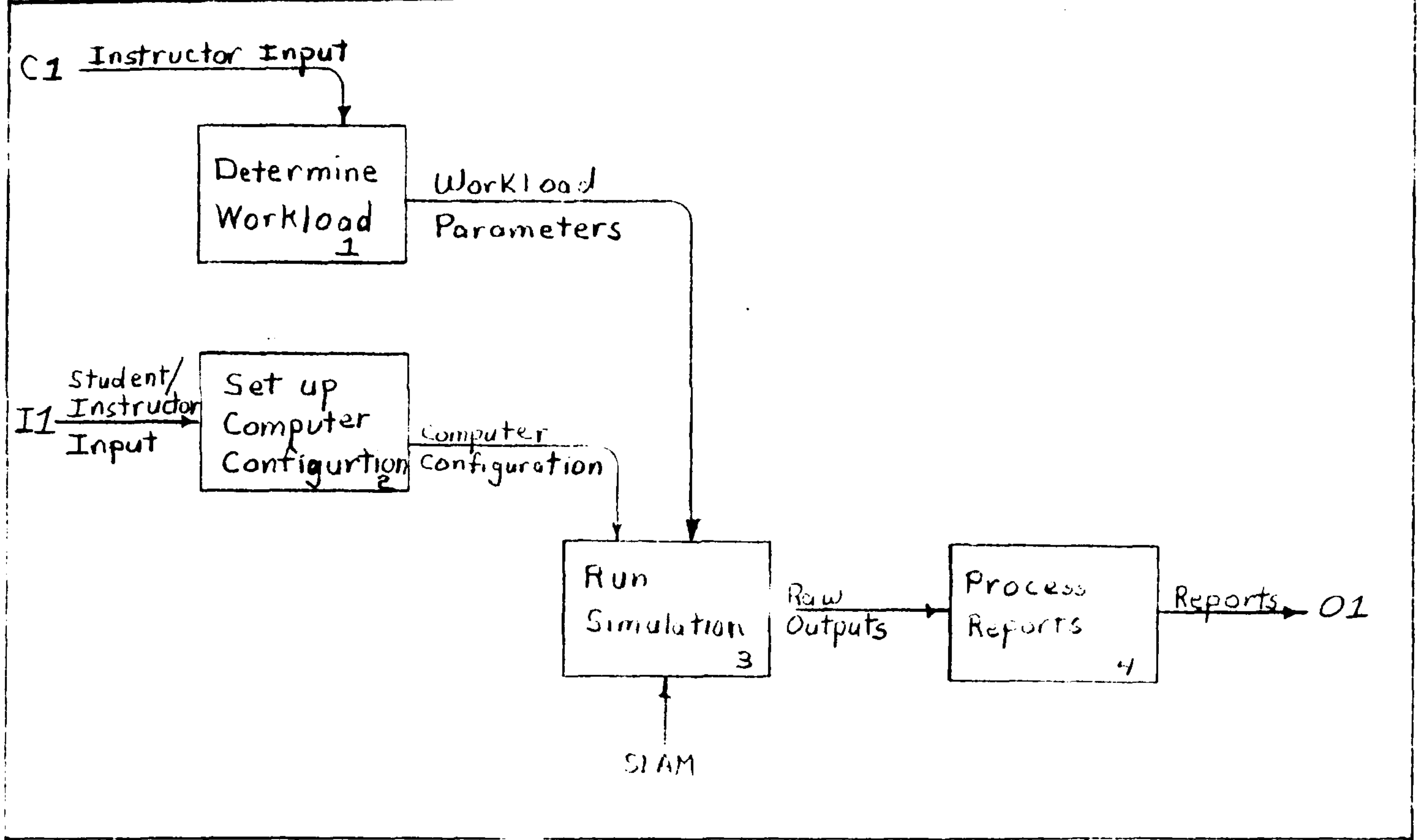
CPESIM II

SADT Diagrams

A1 CPESIM II

CPESIM II will generate a simulated workload as directed by the instructor's input. Either the instructor or the student will set up a particular computer configuration which will be executed using the workload file as input to the SLAM simulation. The raw output for the SLAM simulation will be used to generate accounting information, software monitor information and hardware monitor information.

AUTHOR: David L. Owen	PROJECT: CPESIM	5 Dec 1983	REV: 1.0

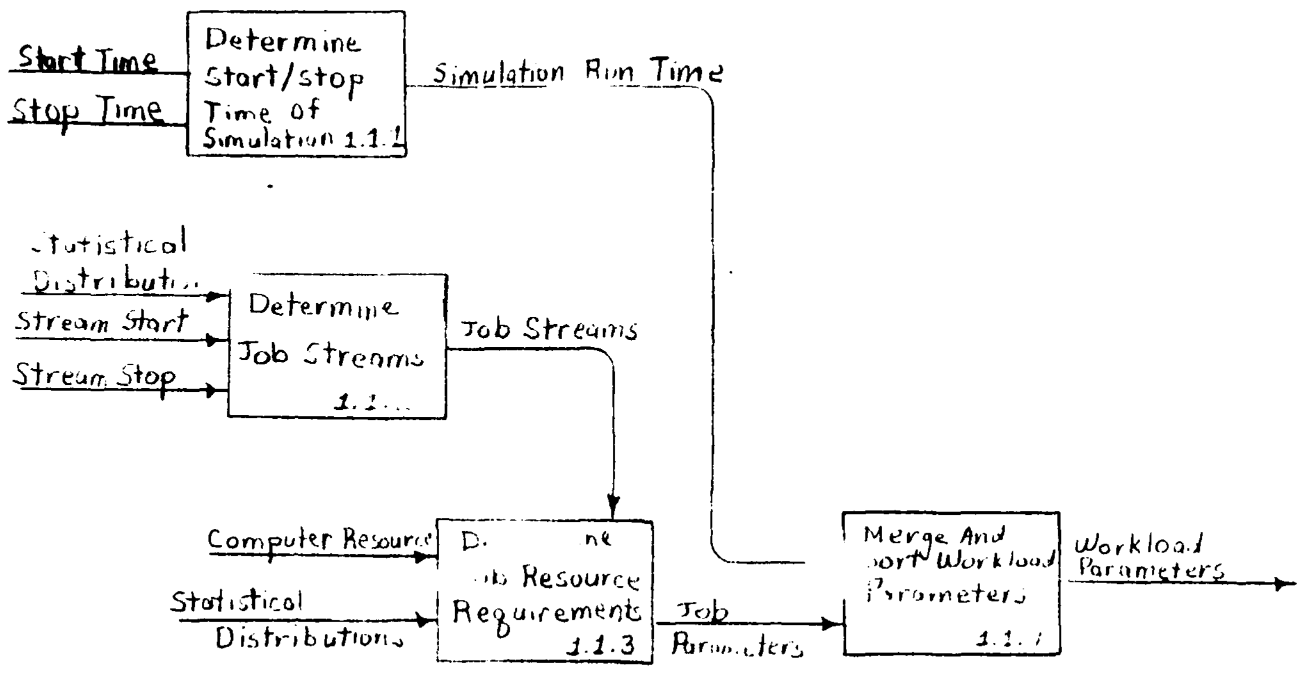


NODE: A1	TITLE: CPESIM II	NUMBER: A-1

A1.1 Determine Workload

Determine Workload will create a file of a simulated computer workload. The start and stop time of the simulation will be entered by the instructor. Then for each job stream the start and stop times of that job stream and the arrival distribution will be entered. Also each of the job's computer resources (arrival time, cpu time required, etc.) must have a distribution associated with it. After all the jobs for all the job streams have been generated, the jobs will be merged and sorted by arrival time.

AUTHOR: David L. Owen	PROJECT: CPESIM	5 Dec 1983	REV: 1.0



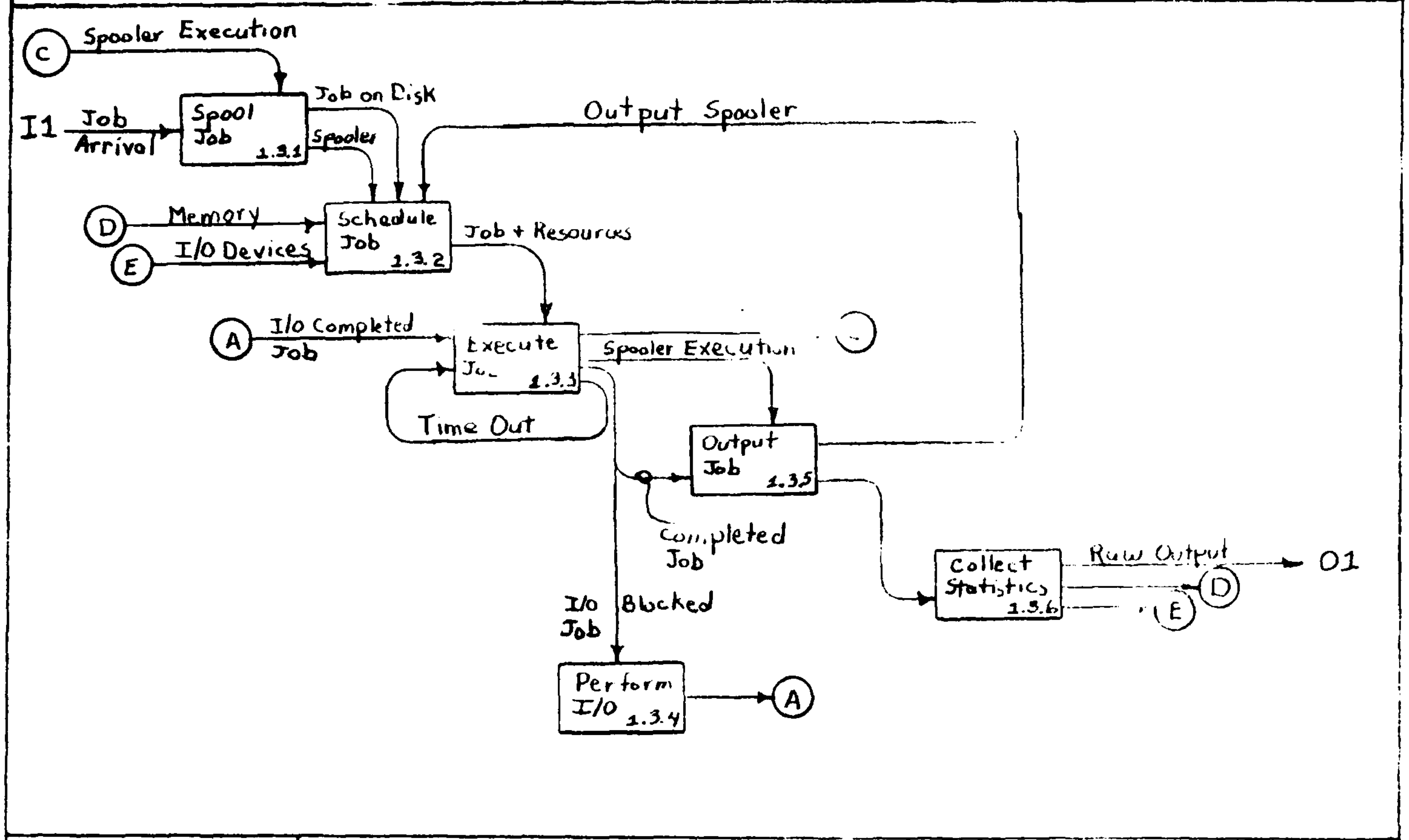
Start Time
Stop Time
Determine Start/stop Time of Simulation 1.1.1
Simulation Run Time
Statistical Distributi..
Stream Start
Stream Stop
Determine Job Streams 1.1...
Job Streams
Computer Resource
Statistical Distributions
D. ne ..b Resource Requirements 1.1.3
Job Parameters
Merge And ..ort Workload Parameters 1.1.?
Workload Parameters

NODE: A1.1	TITLE: Determine Workload	NUMBER: A-?

A1.3 Simulation Run

The simulation run will consist of six major processes. Upon job arrival the job will be spooled onto the disk and be placed in the hold queue. In order to spool a job into memory the "spooler" job has to be executing, which means that the "spooler" job has to be placed into the hold queue. Once the job is in the hold queue the job is ready for the job scheduler. The job scheduler allocates memory and devices to particular jobs. After allocation has taken place the job goes to the execution queue. Execute Job takes a job from the queue and executes the job until a timeout occurs, an I/O is requested or the job is completed. If an I/O was requested then the I/O is performed and the job goes back into the execute queue. When the job completes its execution it is sent to the output job spooler. The output spooler must execute in order to spool a job to the printer. After the job has been printed the job's resources are released and statistics are gathered.

AUTHOR: David L. Owen | PROJECT: CPESIM | 5 Dec 1983 | REV: 1.0

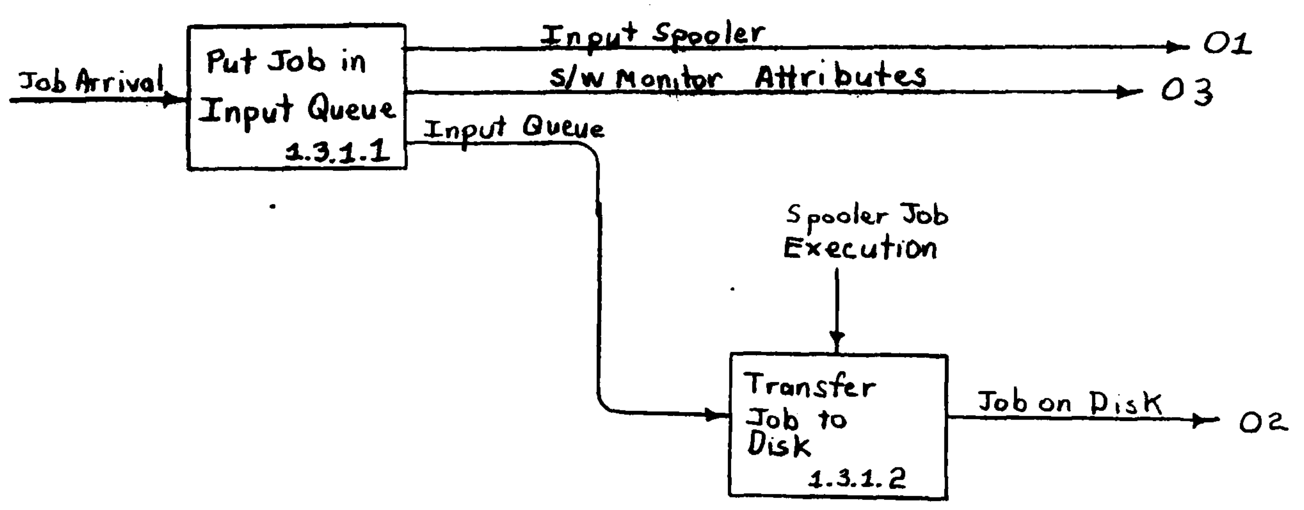


NODE: A1.3 | TITLE: Simulation Run | NUMBER: A-3

A1.3.1 Spool Job

Upon job arrival the job will be placed into the input queue. The "spooler" job will be sent to the hold queue (A1.3.2). Once the "spooler" is executing it will take a job from the input queue and transfer it to disk.

AUTHOR: David L. Owen	PROJECT: CPESIM	5 Dec 1983	REV: 1.0

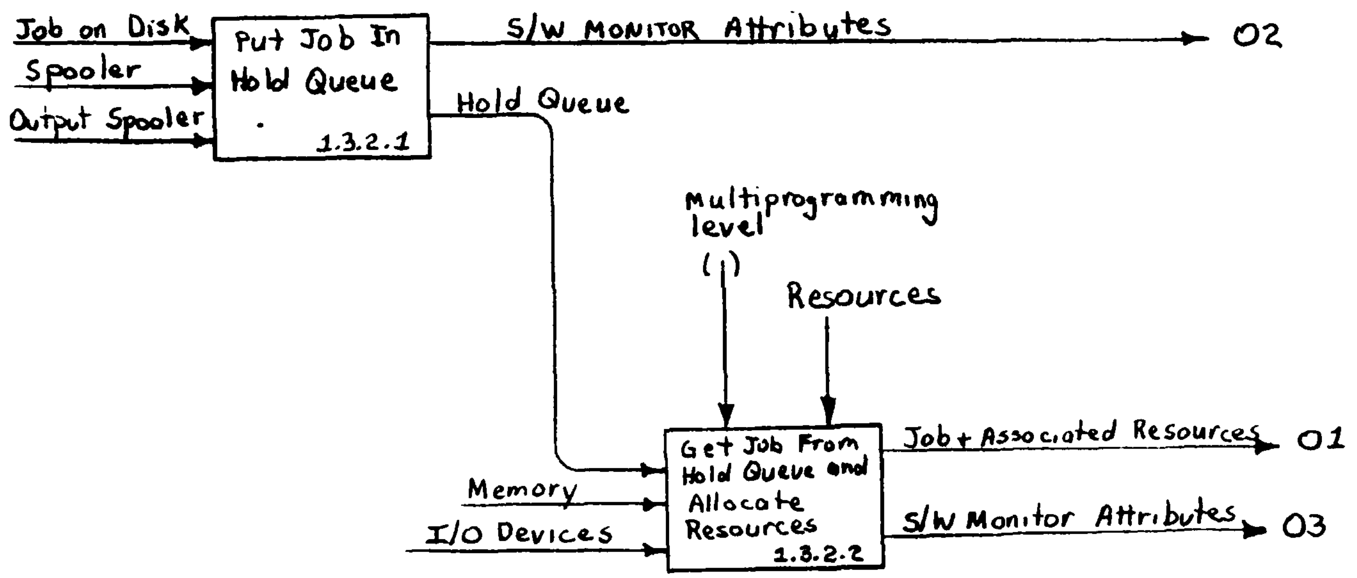


NODE: A.1.3.1	TITLE: Spool Job	NUMBER: A-4

A1.3.2 Schedule Job

Upon arrival of a Job On Disk (user job), a spooler job, or an output spooler job, the job will be placed into the hold queue. Whenever a new job gets into the queue or resources are freed, the queue is searched to see if it can allocate memory or I/O devices to a job in the hold queue. Once a job has been allocated resources it moves to the execute queue (see A1.3.3).

AUTHOR: David L. Owen | PROJECT: CPESIM | 5 Dec 1983 | REV: 1.0

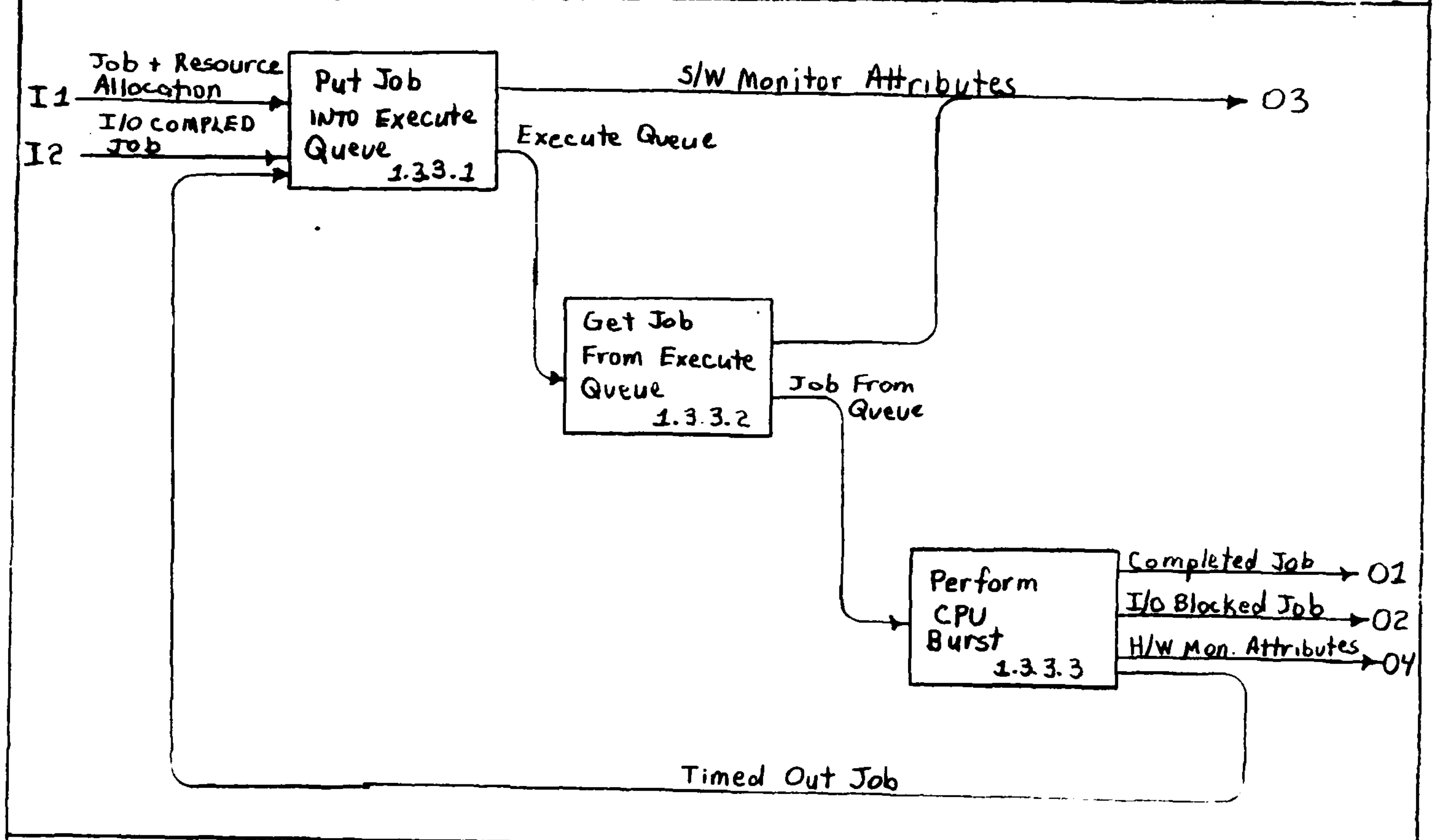


NODE: A1.3.2 | TITLE: Schedule Job | NUMBER: A-5

A1.3.3 Execute Job

After allocating resources, completing an I/O, or timing out, jobs are placed into the execute queue. The first job in the execute queue is taken out of the queue and a cpu burst is performed on it. At the end of the cpu burst the job will be in one of three conditions. If the job is completed then it is sent to Output Job (A1.3.5). If an I/O was requested the the job is sent to Perform I/O (A1.3.4) and if it timed out it is sent back to the execute queue.

AUTHOR: David L. Owen	PROJECT: CPESIM	5 Dec 1983	REV: 1.0

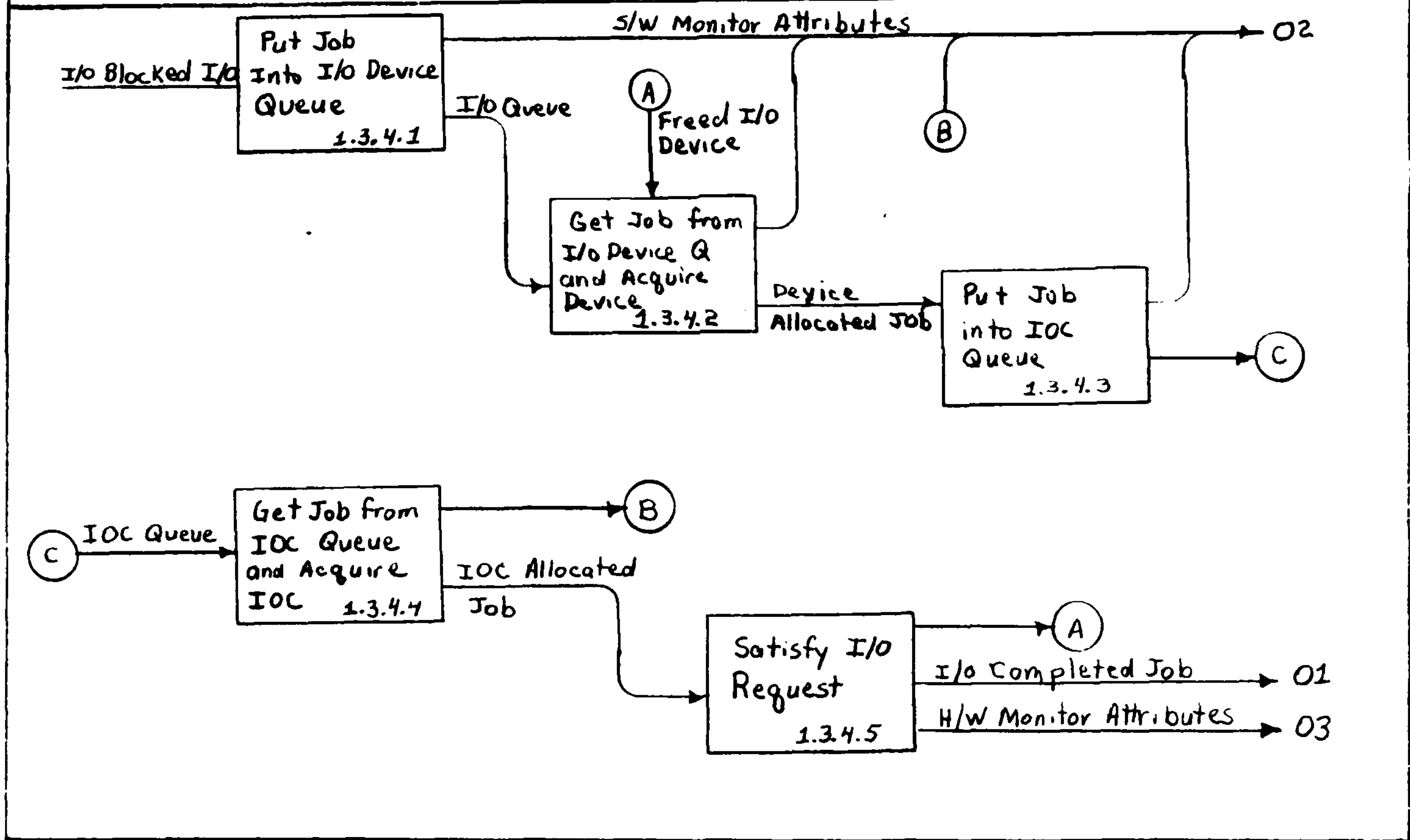


NODE: A1.3.3	TITLE: Execute Job	NUMBER: A-6

A1.3.4 Perform I/O

When a job is blocked because of I/O the job gets put into the IOM queue until it gets a channel to its desired device. After acquiring the channel the job gets put into the device queue until it can get the device and perform its I/O. After completion of the I/O the job is sent back to the execute queue.

AUTHOR: David L. Owen | PROJECT: CPESIM | 5 Dec 1983 | REV: 1.0

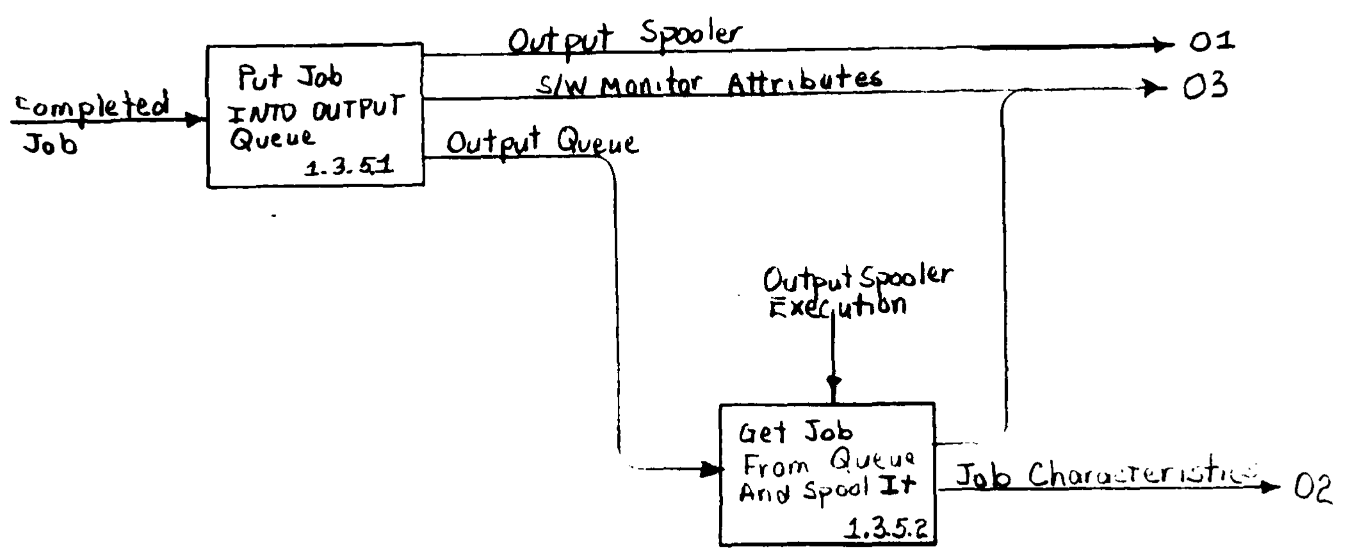

I/O Blocked I/O
Put Job Into I/O Device Queue 1.3.4.1
S/W Monitor Attributes
O2
I/O Queue
A
Freed I/O Device
B
Get Job from I/O Device Q and Acquire Device 1.3.4.2
Device Allocated Job
Put Job into IOC Queue 1.3.4.3
C
C
IOC Queue
Get Job from IOC Queue and Acquire IOC 1.3.4.4
B
IOC Allocated Job
Satisfy I/O Request 1.3.4.5
A
I/O Completed Job
O1
H/W Monitor Attributes
O3

NODE: A1.3.4 | TITLE: Perform I/O | NUMBER: A-7

A1.3.5 Output Job

After the job has completed its cpu time, it is ready to be printed. The job is first placed into the output queue and the "output spooler" job is sent to the hold queue. After the "output spooler" starts execution the job can then be printed. The job characateristics (job statistics and job resources) are sent to Free Resources and Collect Job Statistics (A1.3.6).

AUTHOR: David L. Owen	PROJECT: CPESIM	5 Dec 1983	REV: 1.0



NODE: A1.3.5	TITLE: Output Job	NUMBER: A-8

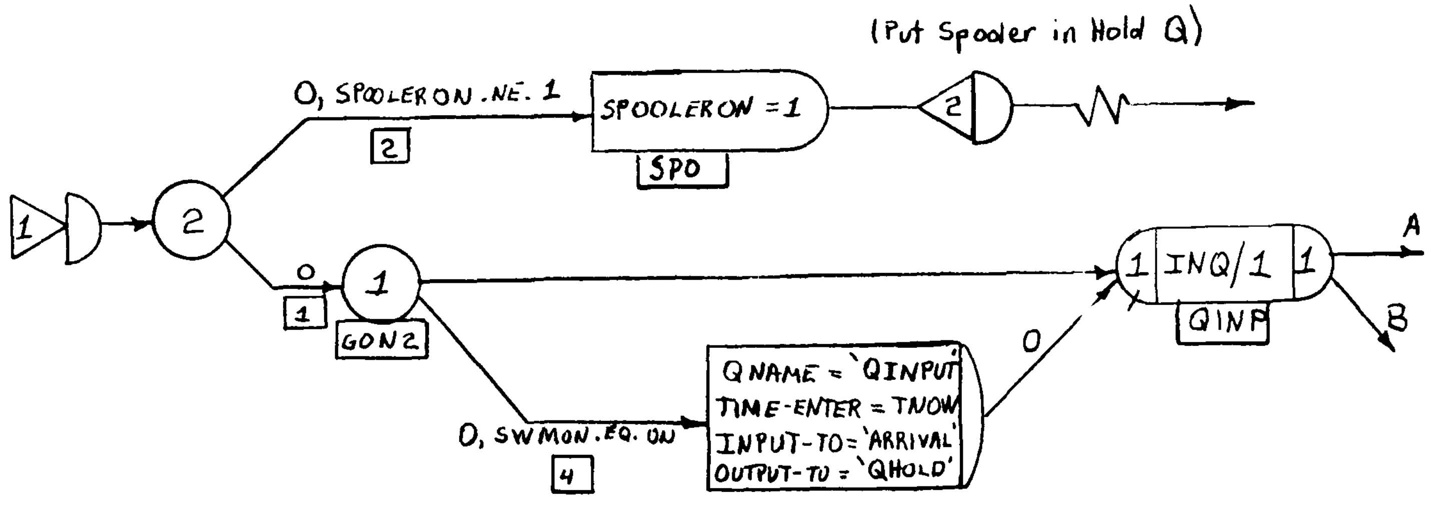
Appendix B

CPESIM II

SLAM Network Drawings

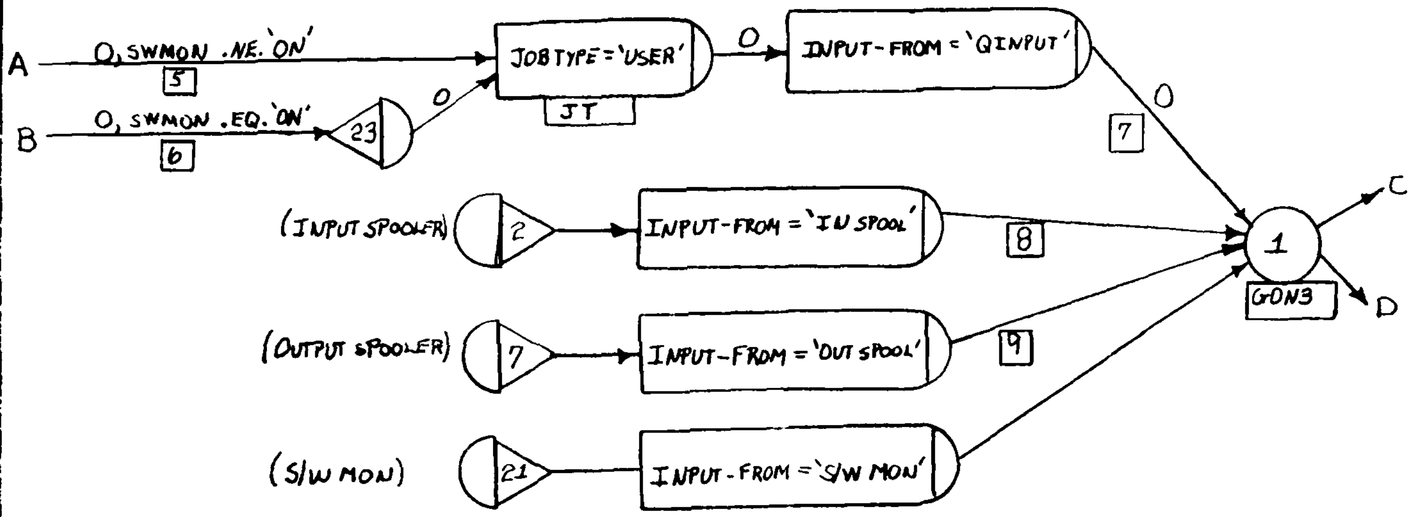
9

AUTHOR: David L. Owen	PROJECT: CPESIM	5 Dec 1983	REV: 1.0



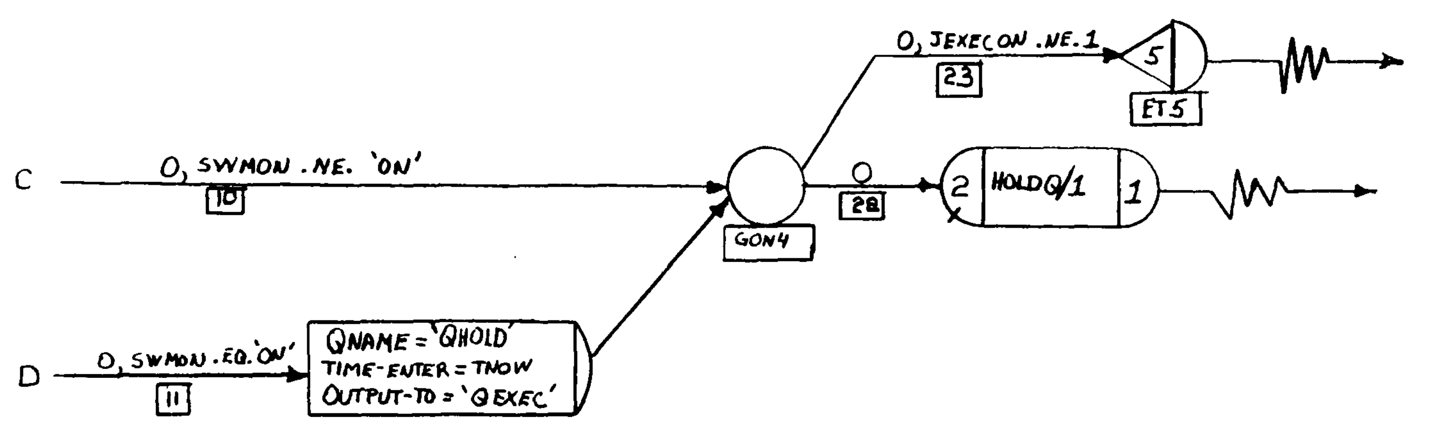
NODE: S.1	TITLE: CPU Network	NUMBER: B-1

AUTHOR: David L. Owen | PROJECT: CPESIM | 5 Dec 1983 | REV: 1.0



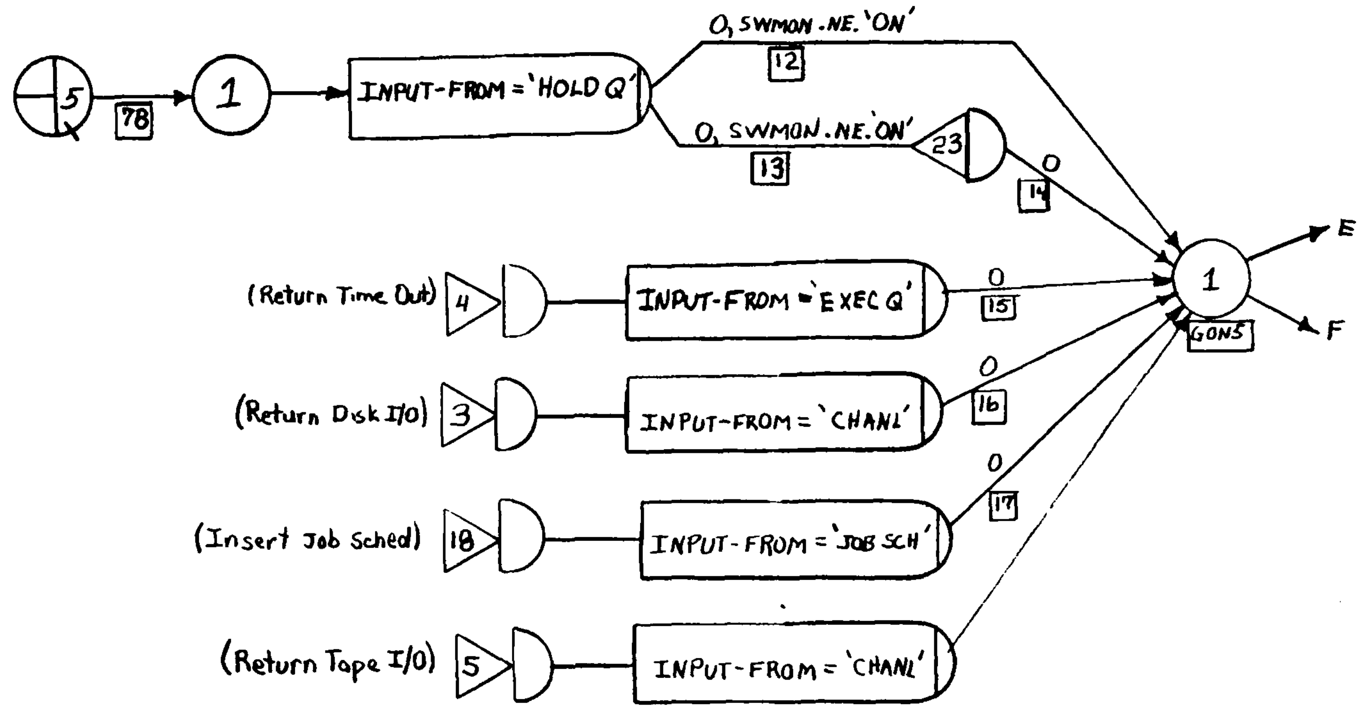
NODE: S.1 | TITLE: CPU Network | NUMBER: B-2

AUTHOR: David L. Owen	PROJECT: CPESIM	5 Dec 1983	REV: 1.0



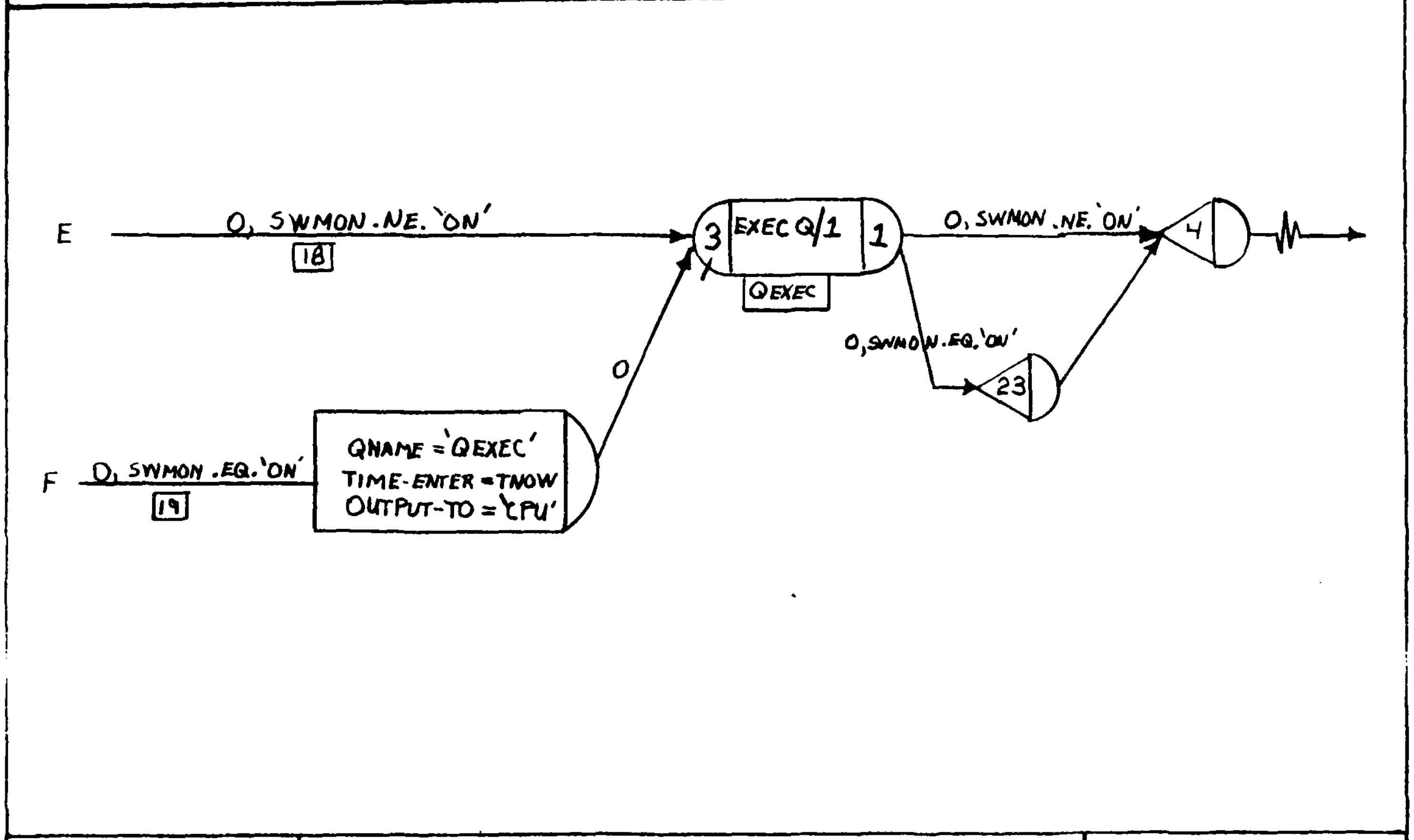
NODE: S.1	TITLE: CPU Network	NUMBER: B-3

AUTHOR: David L. Owen	PROJECT: CPESIM	5 Dec 1983	REV: 1.0



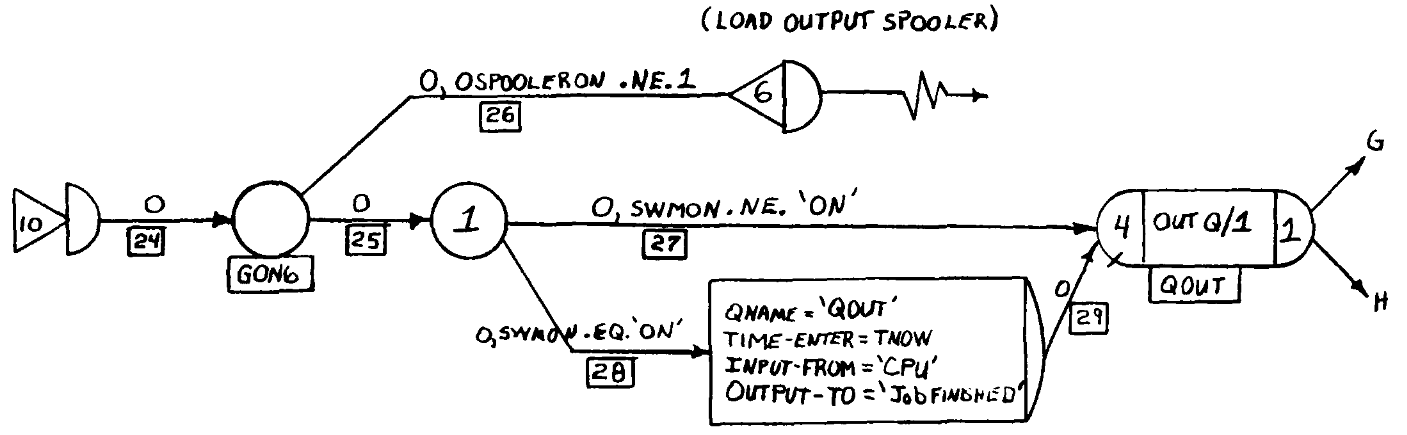
NODE: S.1	TITLE: CPU Network	NUMBER: B-4

AUTHOR: David L. Owen	PROJECT: CPESIM	5 Dec 1983	REV: 1.0



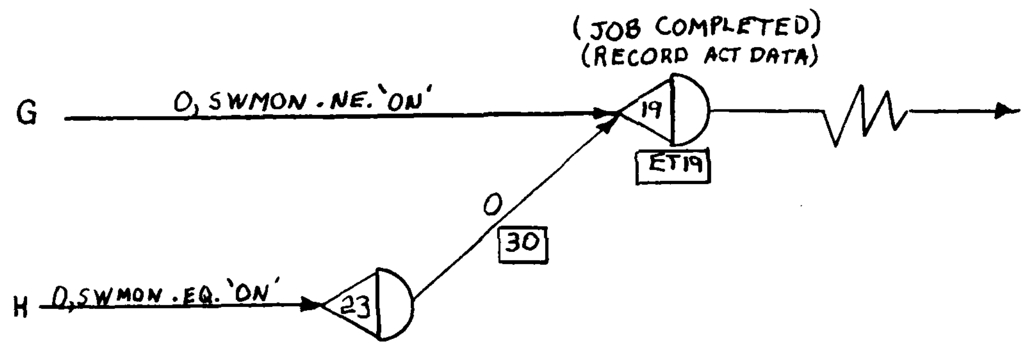
NODE: S.1	TITLE: CPU Network	NUMBER: B-5

AUTHOR: David L. Owen	PROJECT: CPESIM	5 Dec 1983	REV: 1.0



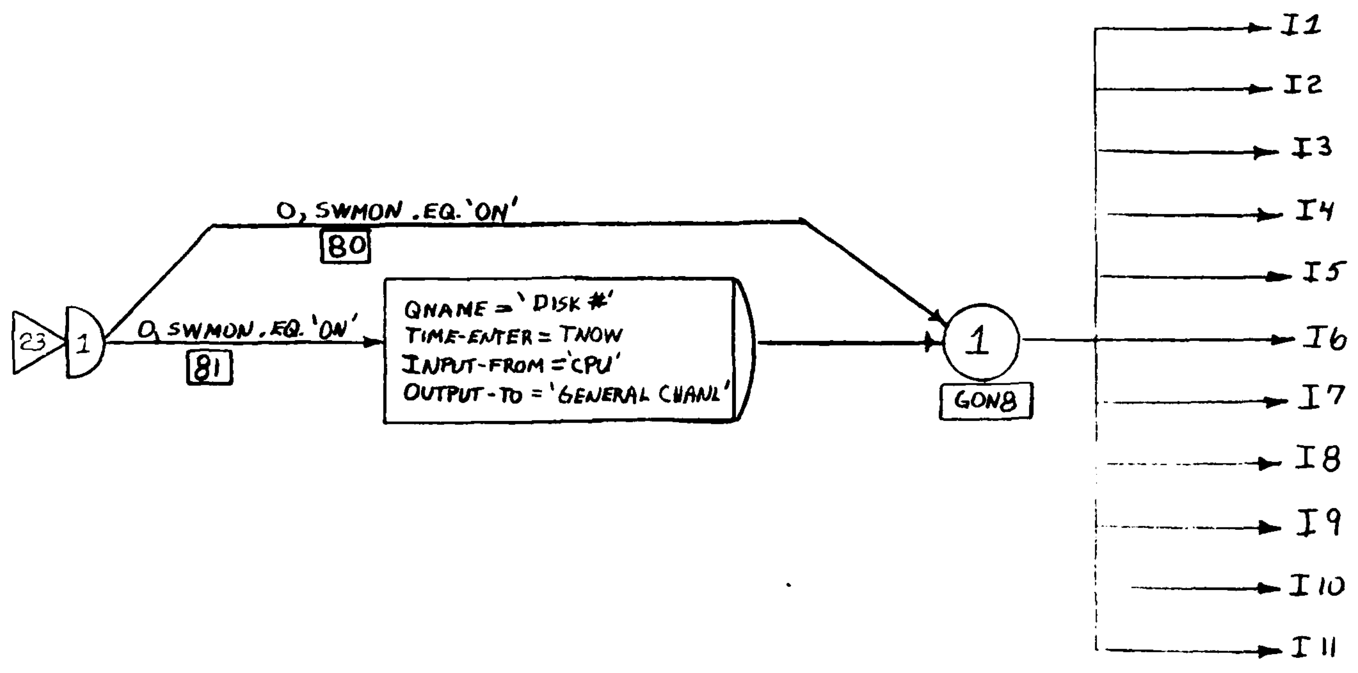
NODE: S.2	TITLE: Output Spooler Network	NUMBER: B-6

AUTHOR: David L. Owen	PROJECT: CPESIM	5 Dec 1983	REV: 1.0



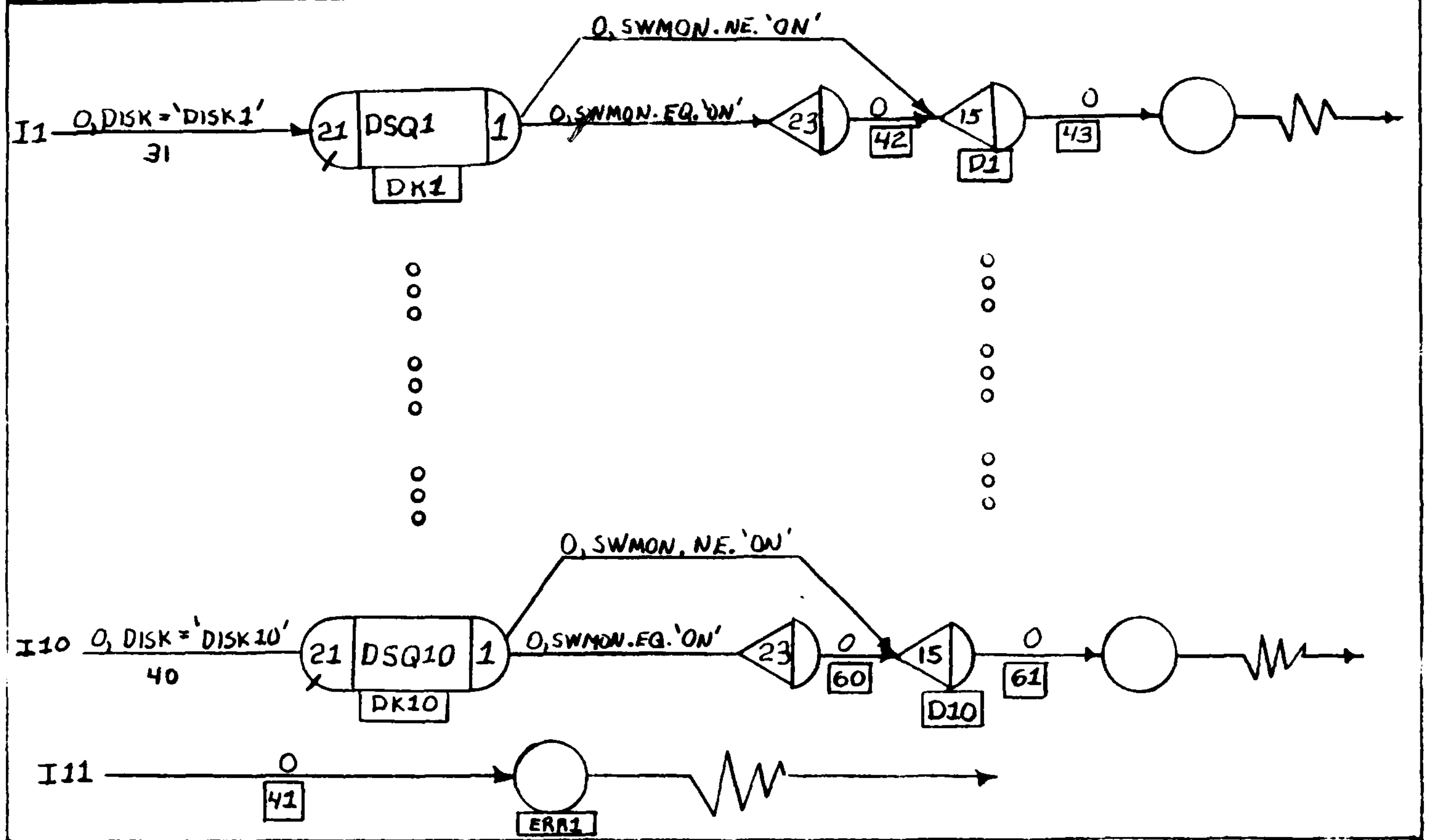
NODE: S.2	TITLE: Output Spooler Network	NUMBER: B-7

AUTHOR: David L. Owen	PROJECT: CPESIM	5 Dec 1983	REV: 1.0



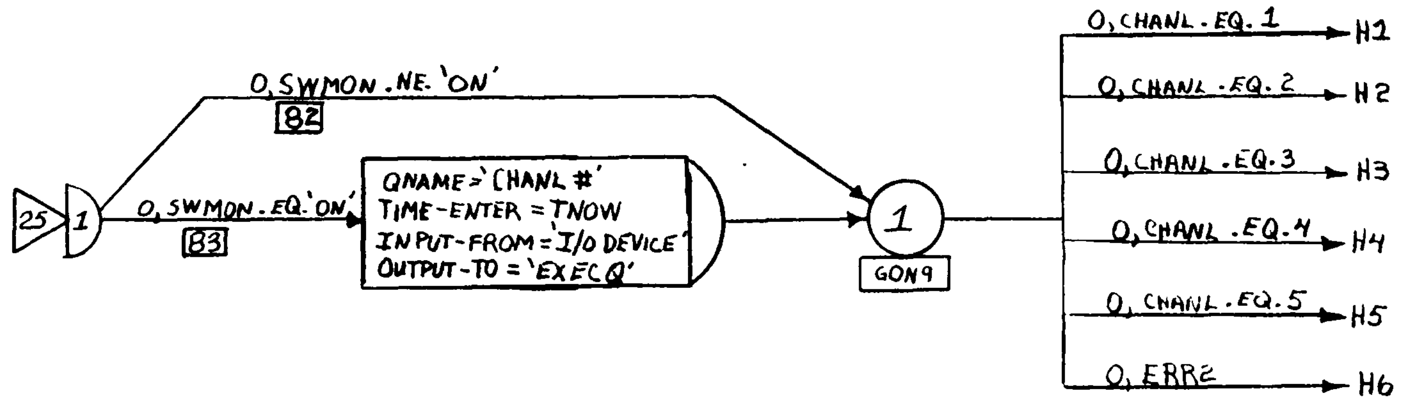
NODE: S.3	TITLE: Disk Network	NUMBER: B-8

AUTHOR: David L. Owen | PROJECT: CPESIM | 5 Dec 1983 | REV: 1.0



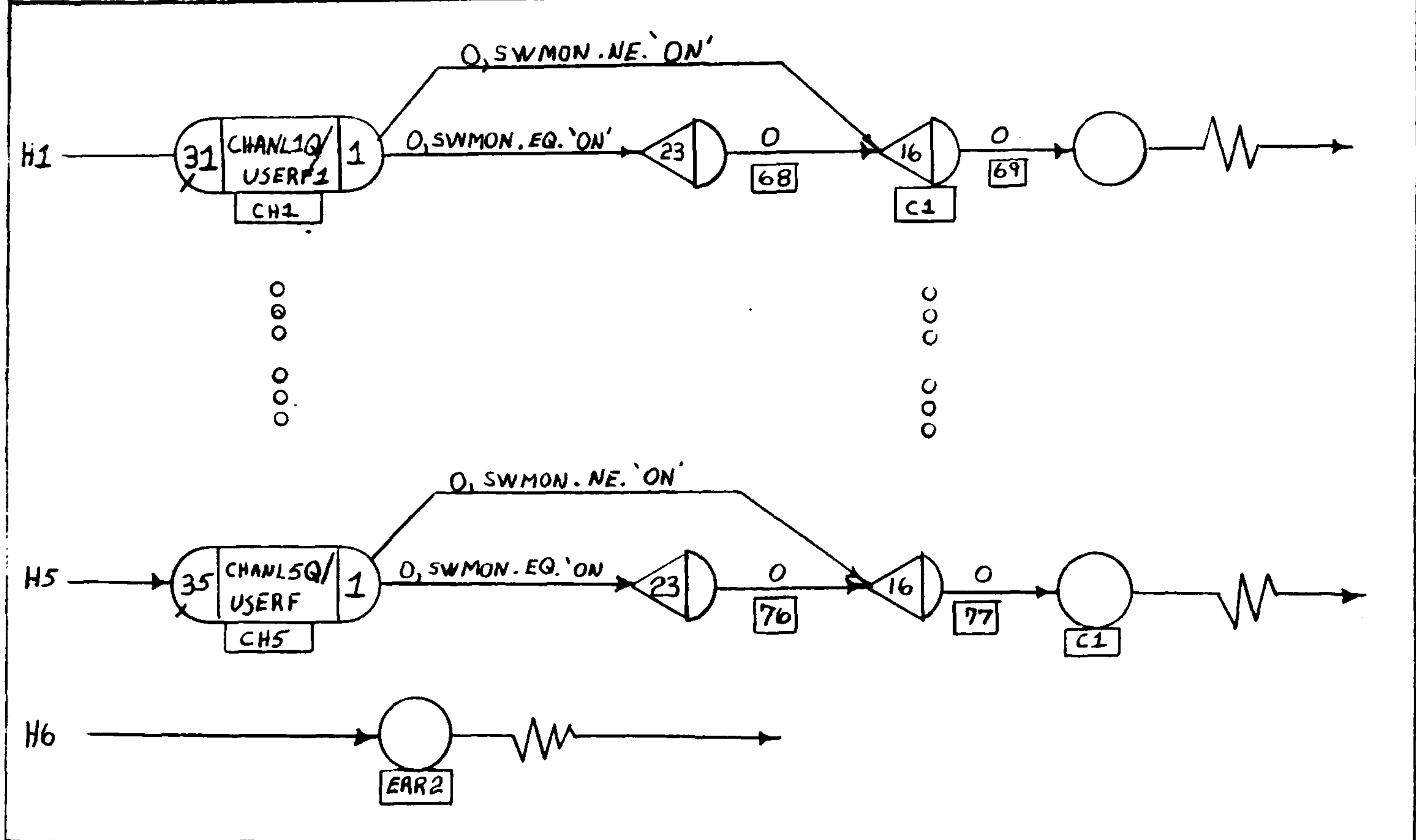
NODE: S.3 | TITLE: Disk Network | NUMBER: B-9

AUTHOR: David L. Owen	PROJECT: CPESIM	5 Dec 1983	REV: 1.0



NODE: S.4	TITLE: Channel Network	NUMBER: B-10

AUTHOR: David L. Owen	PROJECT: CPESIM	5 Dec 1983	REV: 1.0



NODE: S.4	TITLE: Channel Network	NUMBER: B-11

Appendix C

CPESIM II

Structured English

Initialization Routine

1. Read CONFIG FILE

2. Initialize the input, hold, output queues and channels to have 0 resources to start with.

3. Initialize all 'XX' variables.

4. Initialize memory partition sizes.

5. Initialize tape speeds and set them to free status.

6. Initialize disks to be a) available,
   b) their associated channel connections,
   c) and, define disk speeds.

7. Initialize disk count, disk start time, and disk time for each disk to 0 (used in H/W monitor).

8. Initailize tape count, tape start time, and tape time for each tape to 0 (used in H/W monitor).

9. Open job stream, s/w monitor and h/w monitor files

10. Call ARIV at time 0.0

Subroutine ARVL (Job Arrival - Event 1)

1. Read next job's atributes from workload file

2. Initialize cpu time used and i/o time used to 0.0

3. Initialize time of last I/O and time of last tape I/O to 0.0

5. Initialize cpu time left to cpu time required.

5. Schedule job arrival into the network.

Subroutine ISPO (Put Input Spooler in Hold Q - Event 2)

1. Set arrival time to tnow

2. Set memory size to 4k

3. Set Job Type to ´spooler´

4. Set cpu time used to total cpu time used by the input spooler

5. Initialize all other atributes to 0.0

6. Put spooler into holdq

Subroutine ENT1 (Put Job into Input Queue - Event 3)

1. Enter job into network.

2. Call ARVL (to find out when next job should arrive).

Subroutine CPU (CPU Burst - Event 4)

```
1.  cpu-start-time = tnow
    if h/w-mon = 'on' then
      h/w-mon-count = h/w-mon-count + 1

2.  If s/w-monitor not on then
      cpu-ratio = 1.0
     else
      cpu-ratio = .95

3.  If JOB-TYPE = 'user' then  CALL USER

4.  If JOB-TYPE  = 'input spooler' then CALL SPOOL

5.  If JOB-TYPE = 'output spooler' then CALL OSPOL

6.  If JOB-TYPE = 's/w monitor' then CALL SMON

7.  If JOB-TYPE = 'job scheduler' then CALL JSCHD

8.  If JOB-TYPE not equal to one of the above write error
```

Subroutine USER (User CPU Burst - call by cpu)

```
1.  Calculate intermediate variables.
      cpu time used = cpu time required - cpu time left
      i/o-time = time-last-i/o + time-between / cpu-ratio
      tape-time = time-last-tape + time-between-tape /
                  cpu-ration

2.    /* check for job complete */
     If (cpu-time-left /cpu-ratio  time-slice) and
        ((cpu-time-left / cpu-ratio)  (i/o-time)) and
        ((cpu-time-left / cpu-ratio)  (tape-time)) then

          /* schedule completion of job */
          CALL SCHDL(7,tnow + (cpu-time-left /
                    cpu-ratio),atrib)
           /* collect cpu timer data for h/w monitor */

          if h/w-mon = ´on´ then
             cpu-timer = cpu-timer + cpu-time-left /
                         cpu-ratio
         return
      end if

3.    /* check for disk io */
      If ((i/o-time)  (tape-time)) and
         ((i/o-time)  (tnow + time-slice)) then

          /* schedule time of disk request */
          CALL SCHDL (8,i/o-time,atrib)

          /* collect cpu timer data for h/w monitor */
          if h/w-mon = ´on´ then
             cpu-timer = cpu-timer + tnow - i/o-time
           exit
       end if

4.    /* check for tape i/o */
      If (tape-time  (tnow + time-slice)) then

         /* schedule time of the tape request */
         CALL SCHDL (9,tape-time,atrib)

          /* collect cpu timer data for h/w monitor */
          if h/w-mon = ´on´ then
             cpu-timer = cpu-timer + tnow - tape-time

5.  If is none of the above it must be a time out
```

```
/* schedule time-out */
CALL SCHDL (10,tnow + time-slice,atrib)

 /* collect cpu timer data for h/w monitor */
 if h/w-mon = 'on' then
    cpu-timer = cpu-timer + time-slice
```

Subroutine JSCHD (Job Scheduler - called by CPU)

```
1.  for I = 1,num-in-holdq do
      begin
        J = 1
        While (J .LE. number-of-partitions) and
               (found = false) do
          begin
            if size-of-partion .GT. memory-needed and
                   (partion = free) then
              begin
                if (num-of-free-allocatable-devices .GE.
                   atrib(6) ) then
                  begin
                   acquire partition
                   memory size used = partion size
                   Call ATAPE (acquire number of tapes
                        required)
                   get job from holdq
                   insert job into execq
                   if s/w-monitor = 'on' then
                      call userf(23);
                   found = true
                 end if
             end if
        end while
      end for

2.    /* collect cpu timer data for h/w monitor */
      if h/w-mon = 'on' then
         cpu-timer = cpu-timer + job-sched-cpu-time

3.    set job scheduler in execq flag to false

     /* schedule the completion of job scheduler */
4.    CALL SCHDL(18,job-sched-cpu-time, atrib)
```

Subroutine SPOOL (Input Spooler - called by CPU)

```
1.     /* collect cpu timer data for h/w monitor */
       if h/w-mon = 'on' then
           cpu-timer = cpu-timer + spool-cpu-time

2.     if spool-status = 0 then
       /* if start of new job spooling */
        if num-in-inputq not = 0 do
         begin
           copy job atributes from inputq
           num-cards-left = cards
           if s/w-mon = 'on' then call event(23)
           CALL SCHDL(11,tnow + spool-cpu-time,atrib)
        end if
       end if spool-status = 0

3.    if spool-status = 1
      /* write buffer to disk */
        begin
          /* schedule completion of cpu portion then
              do i/o */
          CALL SCHDL(8,tnow + spool-cpu-time,atrib)
      end if

4.    if spool-status = 2 then
      /* read cards onto disk */
        begin
          CALL SCHDL(11,tnow + spool-cpu-time,atrib)
      end if
```

Subroutine OSPOL (Output Spooler - called by CPU)

```
1.      /* collect cpu timer data for h/w monitor */
        if h/w-mon = 'on' then
           cpu-timer = cpu-timer + spool-cpu-time

2.     if ospool-status = 0 then
       /* start of new job */
        begin
          get job from outq
          if s/w-mon = 'on' then call userf(23)
          /* do disk i/o */
          CALL SCHDL(8,tnow + spool-cpu-time,atrib)
        end if
       end if ospool-status = 0

3.    if ospool-status = 1
      /* write buffer to printer */
        begin
          CALL SCHDL(14,tnow + spool-cpu-time,atrib)
      end if

4.    if ospool-status = 2 then
      /* load buffer from disk */
        begin
          /* do disk i/o */
          CALL SCHDL(8,tnow + spool-cpu-time,atrib)
      end if
```

Subroutine SMON (S/W Monitor - called by CPU)

```
1.      s/w-mon = 'on'

2.      free cpu  /* Note that the s/w monitor doesn't take
cpu time */
```

Subroutine LJSCH (Load Job Scheduler into EXECQ - Event 5)

1. Initialize job scheduler atributes
    a. Arrival time = tnow
    b. Job Name = 888 (dummy name)
    c. Job Type = job scheduler
    d. all others = 0.0

2. Put job scheduler into EXECQ

3. Set job scheduler in EXECQ flag to true

Subroutine LOSPL (Load Out Spooler into HOLD Q - Event 6)

1. Set ospooleron flag to on

2. Initialize output spooler atributes
    a. Arrival time = tnow
    b. Job Name = 998 (dummy name)
    c. Memory size = 4.0 k
    d. Job Type = output spooler
    e. CPU Time Used = Total CPU Time Used by Output Spooler
    f. All other atributes = 0.0

3. Put output spooler into hold queue

Subroutine 7 Job Complete

1. If s/w mon = ´on´ then call event(23)
2. cpu-time-used = cpu-time-used + (tnow - cpu-start-time)
3. move job into outq
4. Free cpu
5. Free memory partion
6. Free tapes
7. Put job-scheduler into execq (if it is already there)

Subroutine DISKS (Disk I/O - Event 8)

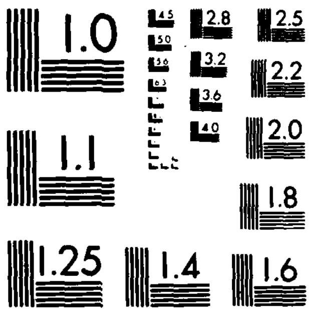
```
1.  cpu-time-used = cpu-time-used + (tnow - cpu-start-time)
    cpu-time-left = cpu-time-left - (tnow - cpu-start-time)
                       * cpu-ratio
    start-io = tnow

2.  free cpu

3.  Look up next-disk
    Disk used = next-disk
    If h/w-mon = 'on' then
       disk-count(X) = disk-count(X) + 1
       disk-start(X) = tnow

4.  Update next-disk

5.  Await Disk "X"  (in SLAM Disk Network)
```

Subroutine 9 Tape I/O

```
1.  cpu-time-used = cpu-time-used + (tnow - cpu-start-time)
    cpu-time-left = cpu-time-left - (tnow - cpu-start-time)
                    * cpu-ratio
    start-io = tnow

2.  free cpu

3.  Look up next-tape
    If h/w-mon = 'on' then
       tape-count(X) = tape-count(X) + 1
       tape-start(X) = tnow

4.  Update next-tape

5.  Look in matrix for channels for tape "X"

6.  Find smallest channel q and put job in channel q

7.  Await data-rate portion of channel

8.  If h/w-mon = 'on' then
       tape-timer(X) = tape-timer(X) + (tnow +
             tape-speed(X)) - tape-start(X)
       channel-time(q) = channel-timer(q) + tape-speed(X)

9.  CALL SCHDL(46,tnow + tape-speed(X),atrib)
```

AD-A138 116 CPESIM II: A COMPUTER SYSTEM SIMULATION FOR COMPUTER PERFORMANCE EVALUATION USE(U) AIR FORCE INST OF TECH WRIGHT-PATTERSON AFB OH SCHOOL OF ENGI.. D L OWEN 2/4

UNCLASSIFIED DEC 83 AFIT/GCS/EE/83D-16 F/G 9/2 NL



MICROCOPY RESOLUTION TEST CHART
NATIONAL BUREAU OF STANDARDS-1963-A

Subroutine TIMEO (Time Out - Event 10)

```
1.  cpu-time-used = cpu-time-used + (tnow - cpu-start-time)

2.  cpu-time-left = cpu-time-left - (tnow - cpu-start-time)
                    * cpu-ratio

3.  Free cpu

4. Place job back into execq
```

Suroutine RCARD (Read Cards into Buffer - Event 11)

```
1.  cpu-time-used = cpu-time-used + (tnow - cpu-start-time)
                        * cpu-ratio
    Note: cpu time for spooling is charged to job but
        is not counted against the job's cpu time required
        to execute the job.

2.  If num-cards-left  buff-size then
        num-cards-read = num-cards-left
      else
        num-cards-read = buff-size

3.  num-cards-left = num-cards-left  -  num-cards-read

4.  Free cpu

5.  /* Schedule completion of loading buffer */
    CALL SCHDL(14,card-speed,atrib)
```

Subroutine DCOMP (Disk Transfer Completed - Event 12)

```
1.  Free channel of portion job was using

2.  Free disk

3.  i/o-time-used = i/o-time-used  + (tnow - start-io)

4.  if JOB-TYPE = 'user'
     time-last-i/o = tnow
     Put job back into execq
    end if

5.  If JOB-TYPE = 'spooler' then
     begin
       /* check for completion of spooling */
       if num-cards-left .LE. 0 then
         begin
           spool-status = 0
           insert job and its atributes into holdq
           if num-in-inputq not = 0 then
             begin
              put spooler back into execq
             end
            else
             begin
               spooleron = 0
              free memory partion of spooler
              put job-scheduler in execq
            end if inputq not = 0
         end
        else
         begin
           spool-status = 2  /* ready to read more cards */
           put spooler back into execq
       end if

     end if

6.  If JOB-TYPE = 'outspooler' then
     begin
      ospool-status = 1  /* ready to print buffer */
      put ospooler back into execq
     end if
```

Subroutine TCOMP (Tape I/O Completion - Event 13)

1. Time-last-tape-i/o = tnow
2. Free channel of portion job was using
3. i/o-time-used = i/o-time-used + (tnow - start-io)
4. Insert job into execq

Subroutine FULLB (Finish Loading Buff w/ Cards - Event 14)

```
1.  /*  Ready to read buffer to disk */
    spool-status = 1

2.  Insert spooler back into execq
```

Subroutine CHANL (Find Channel - Event 15)

```
1.  Look in matrix for channels for disk "X"

2.  Find smallest channel q and put job in channel q
    If h/w-mon = ´on´ then
       channel-count(q) = channel-count(q) + 1

3.  Await data-rate portion of channel (in SLAM
          Channel Network)
```

Subroutine DTRAN (Disk Transfer - Event 16)

```
1.  if h/w-mon = 'on' then
      disk-timer(X) = disk-timer(X) + tnow +
              disk-speed(X) - disk-start(X)

      channel-timer(q) = disk-speed(X)

2.  /* Schedule completion of disk transfer */
    CALL SCHDL(12,tnow + disk-speed(X),atrib)
```

Subroutine FPRNT (Finished Print Buff - EVENT 17)

```
1.  If num-lines-left = 0 then
      begin
        ospool-status = 0
        release job from outq
        if s/wmon = on then event(23)
        if num-in-outq = 0 then
           begin
             free memory-partion of outspooler
             ospool = 0
             ospooleron = 0
             put job scheduler into execq
          else
           begin
             ospool-status = 0
             put outspooler back into execq
         end if
      end
     else
      begin
        ospool-status = 2
        put outspooler back into execq
    end if
```

Subroutine JSCOM (Job Scheduler Completion - Event 18)

1. Free Cpu

2. Job-sched-cpu-used = job-sched-cpu-used + (tnow - cpu-start-time)

Subroutine ACTLG (Accounting Data - Event 19)

1. Write arrival-time, cpu-time-used, memory-used,
   i/o-time-used, priority, allocated-devices,
   and tnow to accounting data file.

Note: alot more data is available for accounting data, if desired.

Subroutine HWMON (H/W Monitor Collection - Event 20)

1. Write tnow, cpu-counter, cpu-timer, all disk, tapes, and channels counters and timers to the h/w monitor raw data file.

2. Reset counters and timers to zero

Subroutine LSMON (Turn S/W Monitor On - Event 21)

1. Open s/w monitor raw data file
2. Insert s/w monitor into hold queue

Subroutine ESMON (Turn S/W Monitor Off - Event 22)

1. Close s/w monitor raw data file

2. Free memory partition

3. Put Job scheduler into execq

Subroutine SMON (Write S/W Monitor Data - Event 23)

1. Write qname, (time-entered - tnow), input-from, and output-to to S/W Monitor file.

Subroutine PBUFF (Print Buffer - Event 24)

```
1.  cpu-time-used = cpu-time-used + (tnow - cpu-start-time)
                       * cpu-ratio
    Note: cpu time for spooling is charged to job but is not
counted against the job's cpu time required to execute the
job.

2.  Free cpu

3.  if num-lines-left  buf-size-lines then
       num-lines-printed = num-lines-left
     else
       num-lines-print = buf-size-lines

4.  num-lines-left = num-lines-left - num-lines-printed

5.  /* schedule completion of printing */
    CALL SCHDL(17,tnow + num-lines-printed *
               printer-speed, atrib)
```

Appendix D

CPESIM II

Code

```
C**********************************************************
C                                                         *
C       DATE:  5 DEC 1983                                 *
C                                                         *
C       VERSION:  1.0                                     *
C                                                         *
C       TITLE: CPESIM II Discrete File                    *
C       FILENAME: SIMF                                    *
C       AUTHOR:  David L. Owen                            *
C       SOFTWARE SYSTEM: CPESIM II                        *
C       USE: Used in combination with SIMS to run CPESIM  *
C       CONTENTS:  EVENTS 1-24, INTLC, EVENT, ATAPE,      *
C          JSCHD, OSPOL, SPOOL, SSMON, USER, USERF        *
C       FUNCTION:  Performs the discrete portion of CPESIM*
C                                                         *
C**********************************************************
C
       PROGRAM MAIN(INPUT,OUTPUT,TAPE5=INPUT,TAPE6=OUTPUT,TAPE7,TAPE11,
     1TAPE12,TAPE13,TAPE14,TAPE15)
       DIMENSION NSET(20000)
       COMMON/SCOM1/ ATRIB(100),DD(100),DDL(100),DTNOW,II,MFA,MSTOP
     1,NCLNR,NCRDR,NPRNT,NNRUN,NNSET,NTAPE,SS(100)
     1,SSL(100),TNEXT,TNOW,XX(100)
      COMMON/UCOM1/A(100), PART(20,2), TAPE(20,3)
      COMMON/UCOM2/DISK(10,7), DCNT(10), DSTRT(10), DSUM(10),DFIN(10),
     1  CCNT(5), CSUM(5), CFIN(5), CSTRT(5), RCNT,RSTRT,RFIN,RSUM,
     1  PCNT, PSTRT, PFIN, PSUM
      COMMON/UCOM3/TAP(10,7), TCNT(10), TSTRT(10), TSUM(10),TFIN(10)
      COMMON/UCOM4/CARD(6),PRNTR(6)
      COMMON/UCOM5/IQ(5)
       COMMON QSET(20000)
       EQUIVALENCE (NSET(1),QSET(1))
       NNSET = 20000
       NCRDR = 5
       NPRNT = 6
       NTAPE = 7
       CALL SLAM
       STOP
       END
```

```
C***********************************************************************
C                                                                     *
C       DATE:  5 DEC 1983                                             *
C       VERSION:  1.0                                                 *
C                                                                     *
C       NAME: INTLC                                                   *
C       EVENT NUMBER: N/A                                             *
C       FUNCTION: Initialize simulation                               *
C       FILES READ: CONFIG                                            *
C       FILES WRITTEN:  none.                                         *
C       EVENTS CALLED: 21, 20, 1                                      *
C       CALLING EVENTS   [illegible]ne.                               *
C       SUBROUTINES CALLED:  ALTER                                    *
C       CALLING SUBROUTINES: none.                                    *
C                                                                     *
C       AUTHOR:  David L. Owen                                        *
C       HISTORY: n/a.                                                 *
C                                                                     *
C***********************************************************************

       SUBROUTINE INTLC
       COMMON/SCOM1/ ATRIB(100),DD(100),DDL(100),DTNOW,II,MFA,MSTOP
     1,NCLNR,NCRDR,NPRNT,NNRUN,NNSET,NTAPE,SS(100)
     1,SSL(100),TNEXT,TNOW,XX(100)
      COMMON/UCOM1/A(100), PART(20,2), TAPE(20,3)
      COMMON/UCOM2/DISK(10,7), DCNT(10), DSTRT(10), DSUM(10),DFIN(10),
     1  CCNT(5), CSUM(5), CFIN(5), CSTRT(5), RCNT,RSTRT,RFIN,RSUM,
     1  PCNT, PSTRT, PFIN, PSUM
      COMMON/UCOM3/TAP(10,7), TCNT(10), TSTRT(10), TSUM(10),TFIN(10)
      COMMON/UCOM4/CARD(6),PRNTR(6)
      COMMON/UCOM5/IQ(5)
      COMMON/UCOM6/IPROBE(5)

      DIMENSION DSPEED(10),DCOST(10),TSPEED(10),TCOST(10),
     1   CSPEED(5),CCOST(5),
     1   PART2(20),IDISK(10,5),
     1     [illegible]E(10,5),IREAD(5),IPRINT(5),ISWMQ(5),IHWCNT(5)
      CHARACTER DNAME(10)*20, TNAME(10)*20, CNAME(5)*20,
     1   RNAME*20,PNAME*20,UNAME*20,SANSWR*1,HANSWR*1,CRATE*20

      REAL HSEC

      PARAMETER (FREE = 0.0, BUSY = 1.0, OFF = 0.0, ON = 1.0)

C***  OPEN CONFIGURATION FILE
      OPEN(UNIT=15,FILE='TAPE15',STATUS='OLD',ERR=990,IOSTAT=IOS,
     1     ACCESS='SEQUENTIAL',FORM='FORMATTED')

C****************************************************************
```

```
C***  READ DATA FROM CONFIGUARATION FILE         ***
C*****************************************************

C***  NUMBER OF CPUS
      READ (UNIT=15,FMT=100,IOSTAT=IOS,ERR=999)NCPUS
C***  TYPE OF CPU
      READ (UNIT=15,FMT=101,IOSTAT=IOS,ERR=999)
     1       UNAME,USPEED,UCOST
C***  TIME SLICE
      READ (UNIT=15,FMT=104,IOSTAT=IOS,ERR=999)TSLICE
C***  READ NUMBER OF MEMORY PARTIONS
      READ (UNIT=15,FMT=100,IOSTAT=IOS,ERR=999)NPARTS
C***  READ SIZE OF MEMORY PARTIONS
      DC 40 I=1,NPARTS
         READ (UNIT=15,FMT=104,IOSTAT=IOS,ERR=999)PART2(I)
40    CONTINUE
C***  READ NUMBER OF CHANNELS
      READ (UNIT=15,FMT=100,IOSTAT=IOS,ERR=999)NCHAN
C***  READ CHANNEL'S NAME, SPEED AND COST
      DO 41 I=1,NCHAN
         READ (UNIT=15,FMT=101,IOSTAT=IOS,ERR=999)
     1           CNAME(I),CSPEED(I),CCOST(I)
41    CONTINUE
C***  READ NUMBER OF DISKS
      READ (UNIT=15,FMT=100,IOSTAT=IOS,ERR=999)NDISK
C***  READ DISK'S NAME, SPEED, COST AND CHANNEL CONNECTIONS
      DO 42 I=1,NDISK
         READ (UNIT=15,FMT=105,IOSTAT=IOS,ERR=999)
     1     DNAME(I),DSPEED(I),DCOST(I),(IDISK(I,K),K=1,5)
42    CONTINUE
C***  READ NUMBER OF TAPES
      READ (UNIT=15,FMT=100,IOSTAT=IOS,ERR=999)NTAPE
C***  READ TAPE'S NAME, SPEED, COST AND CHANNEL CONNECTIONS
      DO 43 I=1,NTAPE
         READ (UNIT=15,FMT=105,IOSTAT=IOS,ERR=999)
     1     TNAME(I),TSPEED(I),TCOST(I),(ITAPE(I,K),K=1,5)
43    CONTINUE
C***  READ CARD READER'S NAME, SPEED, COST AND CHANNEL CONNECTIONS
      READ (UNIT=15,FMT=105,IOSTAT=IOS,ERR=999)
     1     RNAME,RSPEED,RCOST,(IREAD(K),K=1,5)
C***  READ LINE PRINTER'S NAME, SPEED, COST AND CHANNEL CONNECTIONS
      READ (UNIT=15,FMT=105,IOSTAT=IOS,ERR=999)
     1     PNAME,PSPEED,PCOST,(IPRINT(K),K=1,5)
C***  READ IF SOFTWARE MONITOR IS DESIRED
      READ (UNIT=15,FMT=106,IOSTAT=IOS,ERR=999)SANSWR
C***  READ START TIME, STOP TIME, AND QUEUES IF DESIRED
      IF (SANSWR .EQ. 'Y') THEN
         READ (UNIT=15,FMT=107,IOSTAT=IOS,ERR=999)
     1           ISDAY,ISHOUR,ISMIN,SSEC
         READ (UNIT=15,FMT=107,IOSTAT=IOS,ERR=999)
     1          JSDAY,JSHOUR,JSMIN,SSSEC
           READ (UNIT=15,FMT=109,IOSTAT=IOS,ERR=999)(ISWMQ(I),I=1,5)
        END IF
C***    READ IF HARDWARE MONITOR IS DESIRED
        READ (UNIT=15,FMT=106,IOSTAT=IOS,ERR=999)HANSWR
C***    READ START TIME, STOP TIME, TIMERS AND COUNTERS IF DESIRED
        IF (HANSWR .EQ. 'Y') THEN
           READ (UNIT=15,FMT=107,IOSTAT=IOS,ERR=999)
     1          IHDAY,IHHOUR,IHMIN,HSEC
           READ (UNIT=15,FMT=107,IOSTAT=IOS,ERR=999)
     1          JHDAY,JHHOUR,JHMIN,SHSEC
           READ (UNIT=15,FMT=104,IOSTAT=IOS,ERR=999)RATEHW
           READ (UNIT=15,FMT=109,IOSTAT=IOS,ERR=999)
     1          IHTIM1,IHTIM2,(IHWCNT(I),I=1,3)
        END IF

100     FORMAT(I2)
101     FORMAT(A20,1X,F10.4,1X,F8.2)

103     FORMAT(I5)
104     FORMAT(T22,F10.4)
105     FORMAT(A20,1X,F10.4,1X,F8.2,1X,5(1X,I1))
106     FORMAT(A1)
107     FORMAT(T22,3(I4,1X),F8.4)
109     FORMAT(5(I2,1X))

        PRINT *,'CONFIGURATION FILE READ SUCCESSFULLY'


C*****************************************************
C***    PRINT DATA FROM CONFIGUARATION FILE         ***
C*****************************************************

C***    NUMBER OF CPUS
        PRINT *,NCPUS
C***    TYPE OF CPU
        PRINT *,UNAME,USPEED,UCOST
C***    TIME SLICE
        PRINT *,'TIME SLICE = ',TSLICE
C***    PRINT NUMBER OF MEMORY PARTIONS
        PRINT *,NPARTS
C***    PRINT SIZE OF MEMORY PARTIONS
        DO 240 I=1,NPARTS
           PRINT *,I,PART2(I)
240      CONTINUE
C***    PRINT NUMBER OF CHANNELS
        PRINT *,NCHAN
C***    PRINT CHANNEL'S NAME, SPEED AND COST
        DO 241 I=1,NCHAN
           PRINT *,CNAME(I),CSPEED(I),CCOST(I)
```

```
241    CONTINUE
C***  PRINT NUMBER OF DISKS
      PRINT *,NDISK
C***  PRINT DISK'S NAME, SPEED, COST AND CHANNEL CONNECTIONS
      DO 242 I=1,NDISK
       PRINT *,DNAME(I),DSPEED(I),DCOST(I),
     1     (IDISK(I,K),K=1,5)
242    CONTINUE
C***  PRINT NUMBER OF TAPES
      PRINT *,NTAPE
C***  PRINT TAPE'S NAME, SPEED, COST AND CHANNEL CONNECTIONS
      DO 243 I=1,NTAPE
         PRINT *,TNAME(I),TSPEED(I),
     1 TCOST(I),(ITAPE(I,K),K=1,5)
243    CONTINUE
C***  PRINT CARD READER'S NAME, SPEED, COST AND CHANNEL CONNECT
      PRINT *,RNAME,RSPEED,RCOST,
     1     (IREAD(K),K=1,5)
C***  PRINT LINE PRINTER'S NAME, SPEED, COST AND CHANNEL CONNECTIONS
      PRINT *,PNAME,PSPEED,PCOST,
     1     (IPRINT(K),K=1,5)
C***  PRINT IF SOFTWARE MONITOR IS DESIRED
      PRINT *,SANSWR
C***  PRINT START TIME, STOP TIME, AND QUEUES IF DESIRED
      IF (SANSWR .EQ. 'Y') THEN
         PRINT *,ISDAY,ISHOUR,ISMIN,SSEC
         PRINT *,JSDAY,JSHOUR,JSMIN,SSSEC
         PRINT *,(ISWMQ(I),I=1,5)
      END IF
C***  PRINT IF HARDWARE MONITOR IS DESIRED
      PRINT *,HANSWR
C***  PRINT START TIME, STOP TIME, TIMERS AND COUNTERS IF DESIRED
      IF (HANSWR .EQ. 'Y') THEN
         PRINT *,IHDAY,IHHOUR,IHMIN,HSEC
         PRINT *,JHDAY,JHHOUR,JHMIN,SHSEC
         PRINT *,RATEHW
         PRINT *,IHTIM1,IHTIM2,(IHWCNT(I),I=1,3)
      END IF

C*****************************************************
C***  INITIALIZE SIMULATION VARIABLES             ***
C*****************************************************


C***  MAKE THE INPUT QUEUE HAVE 0 RESOURCES AT START OF PROGRAM
      CALL ALTER(1,-1)

C***  MAKE THE HOLD QUEUE HAVE 0 RESOURCES AT START OF PROGRAM
      CALL ALTER(2,-1)
```

```
C***  CONFIGURE MODEL TO HAVE THE RIGHT NUMBER OF CPUS
      NCPUS = NCPUS - 1
      CALL ALTER(3,NCPUS)

C***  MAKE THE OUTPUT QUEUE HAVE 0 RESOURCES AT START OF PROGRAM
      CALL ALTER(4,-1)


C***  INITIALIZE SPOOLERON FLAG
      XX(1) = OFF
C***  INITIALIZE S/W MONITOR FALG
      XX(2) = OFF

C***  INITIALIZE NUMBER OF MEMORY PARTIONS
      XX(3) = NPARTS
C***  INITIALIZE PARTITION SIZES AND STATUS
      DO 5 I=1,XX(3)
         PART(I,1) = PART2(I)
         PART(I,2) = FREE
5     CONTINUE
      TEMP = XX(3) + 1
      DO 6 I=TEMP,20
         PART(I,1) = 0.
         PART(I,2) = BUSY
6     CONTINUE

C***  INITIALIZE THE CPU TO RUN AT 100% CAPACITY
C***  NOTE: WHEN S/W MON IS RUNNING IT GETS SET TO 95% BY SSMON
      XX(5) = 1.0
C***  INITIALIZE RELATIVE CPU RATIO
      XX(6) = USPEED
C***  INITIALIZE TIME SLICE (IN SECONDS)
      XX(7) = TSLICE

C***  INITIALIZE NUMBER OF TAPE DRIVES
      XX(9) = NTAPE
C***  INITIALIZE NUMBER OF AVAILABLE TAPE DRIVES
      XX(10) = XX(9)
C***  INTALIZE TAPES SPEED AND STATUS
      DO 7 I=1,XX(9)
      TAPE(I,1) = TSPEED(I)
      TAPE(I,2) = FREE
      TAPE(I,3) = 0.
7     CONTINUE
C***  INITIALIZE TAPES CHANNEL CONNECTIONS AND SPEED
      DO 11 I=1,XX(9)
        DO 60 K=1,5
         TAP(I,K) = ITAPE(I,K)
60      CONTINUE
        TAP(I,6) = TSPEED(I)
```

```
          TAP(I,7) = 0.
11      CONTINUE
C***    INITIALIZE NEXT TAPE
        XX(24) = 0.

C***    INITIALIZE JOB SCHEDULER IN EXECQ FLAG
        XX(11) = OFF
C***    INITIALIZE OSPOOLERON FLAG
        XX(12) = OFF
C***    INITIALIZE CPU TIME REQUIRED FOR JOB SCHEDULER
        XX(13) = 3.0
C***    INITIALIZE CPU TIME FOR INPUT SPOOLER TO EXECUTE
        XX(14) = .001
C***    INITIALIZE INPUT SPOOLER STATUS TO A NEW JOB
        XX(15) = 0.0
C***    INITIALIZE OUTPUT SPOOLER STATUS TO A NEW JOB
        XX(16) = 0.0
C***    INITIALIZE BLOCK SIZE (BYTES)
        XX(17) = 1024.

C***    INITIALIZE CARD READER SPEED (CARDS/MINUTE)
        XX(18) = RSPEED
C***    INITIALIZE CARD RECORD SIZE (BYTES)
        XX(19) = 80.
C***    INITIALIZE CARDS PER BUFFER
        XX(20) = NINT((XX(17) / XX(19)) - .5)
C***    INITIALIZE CARD READER SPEED AND CHANNELS
        DO 64 I=1,5
           CARD(I) = IREAD(I)
64      CONTINUE

C***    INITIALIZE NEXT DISK
        XX(21) = 1
C***    INITIALIZE NUMBER OF DISK DRIVES
        XX(22) = NDISK
C***    INITIALIZE DISKS CONNECTIONS AND SPEEDS
        DO 8 I=1,XX(22)
          DO 61 K=1,5
           DISK(I,K) = IDISK(I,K)
61        CONTINUE
          DISK(I,6) = DSPEED(I)
8       CONTINUE

C***    INITAILIZE NUMBER OF CHANNELS
        XX(23) = NCHAN
C***    SET CHANNEL DATA RATE FLOW
        DO 65 I=1,NCHAN
          ITEMP = CSPEED(I)
          ITEMP2 = 30 + I
          CALL ALTER(ITEMP2,ITEMP)
```

```
65    CONTINUE

C***  INITIALIZE PRINTER SPEED (LINES PER MINUTE)
      XX(25) = PSPEED
C***  INITIALIZE LINE RECORD SIZE (BYTES)
      XX(26) = 132.
C***  INITIALIZE LINES PER BUFFER
      XX(27) = NINT(XX(17) / XX(26) - .5)
C***  INITIALIZE LINE PRINTER CHANNEL CONNECTIONS
      DO 62 I=1,5
         PRNTR(I) = IPRINT(I)
62    CONTINUE

C***  INITIALIZE H/W MONITOR FLAG
      XX(30) = OFF
C***  INITIALIZE CPU COUNTER FOR H/W MONITOR
      XX(31) = 0.
C***  INITIALIZE CPU SUM FOR H/W MONITOR
      XX(32) = 0.
C***  INITIALIZE H/W MONITOR START/STOP TIME AND INTERVAL
      IF (HANSWR .NE. 'Y') THEN
C*       INTIALIZE TO INFINITE AND NO PROBE CONNECTIONS
         XX(33) =  999999999.
         XX(34) =  999999999.
         XX(35) =  999999999.
         IPROBE(1) = 0
         IPROBE(2) = 0
         IPROBE(3) = 0
         IPROBE(4) = 0
         IPROBE(5) = 0
       ELSE
         XX(33) = (IHDAY * 86400.) + (IHHOUR * 3600.) +
     1            (IHMIN * 60.) + HSEC
         XX(34) = (JHDAY * 86400.) + (JHHOUR * 3600.) +
     1            (JHMIN * 60.) + SHSEC
         XX(35) = RATEHW
         IPROBE(1) = IHTIM1
         IPROBE(2) = IHTIM2
         IPROBE(3) = IHWCNT(1)
         IPROBE(4) = IHWCNT(2)
         IPROBE(5) = IHWCNT(3)
      END IF

C***  INITIALIZE CPU START TIME FOR H/W MONITOR
      XX(36) = -1.0
C***  INTIALIZE CPU FIN TIME FOR H/W MONITOR
      XX(37) = 0.

C***  INITIALIZE TOTAL CPU TIME USED BY INPUT SPOOLER
      XX(40) = 0.
```

```
C***  INITIALIZE TOTAL CPU TIME USED BY OUTPUT SPOOLER
      XX(41) = 0.
C***  INITIALIZE TOTAL CPU TIME USED BY JOB SCHEDULER
      XX(42) = 0.

C***  INITIALIZE S/W MONITOR START/STOP TIME AND QUEUES
      IF (SANSWR .NE. 'Y') THEN
         XX(43) = 999999999.
         XX(44) = 999999999.
         IQ(1) = 0
         IQ(2) = 0
         IQ(3) = 0
         IQ(4) = 0
         IQ(5) = 0
        ELSE
         XX(43) = (ISDAY * 86400.) + (ISHOUR * 3600.) +
     1            (ISMIN * 60.) + SSEC
         XX(44) = (JSDAY * 86400.) + (JSHOUR * 3600.) +
     1            (JSMIN * 60.) + SSSEC
         DO 98 I=1,5
           IQ(I) = ISWMQ(I)
98       CONTINUE
      END IF


C***  OPEN JOB STREAM FILE
      OPEN(UNIT=11,FILE='TAPE11',STATUS='OLD',
     1     ACCESS='SEQUENTIAL',FORM='FORMATTED')

C***  OPEN ACTIVITY LOG FILE
      OPEN(UNIT=12,FILE='TAPE12',STATUS='NEW',
     1     ACCESS='SEQUENTIAL',FORM='FORMATTED')

      IF (SANSWR .EQ. 'Y') THEN
C***     OPEN S/W MONITOR DATA FILE
         OPEN(UNIT=14,FILE='TAPE14',STATUS='NEW',
     1        ACCESS='SEQUENTIAL',FORM='FORMATTED')
C***     SCHEDULE START OF S/W MONITOR
         CALL SCHDL(21,XX(43),ATRIB)
      END IF


      IF (HANSWR .EQ. 'Y') THEN
C***     OPEN H/W MONITOR DATA FILE
         OPEN(UNIT=13,FILE='TAPE13',STATUS='NEW',
     1        ACCESS='SEQUENTIAL',FORM='FORMATTED')
C***     SCHEDULE START OF H/W MONITOR
         CALL SCHDL(20,XX(33),ATRIB)
C***     SCHEDULE STOP OF H/W MONITOR
         CALL SCHDL(20,XX(34),ATRIB)
      END IF

      DO 860 I=1,44
        PRINT *,´XX(´,I,´) = ´,XX(I)
860   CONTINUE

C***  SCHEDULE THE READING OF THE FIRST JOB´S ATRIBUTES
      CALL SCHDL(1,0.,ATRIB)

      RETURN

990   PRINT *,´ERROR IN OPENING CONFIG FILE  IOSTAT = ´,IOS
      RETURN

999   PRINT *,´ERROR IN READING CONFIG FILE  IOSTAT = ´,IOS
      RETURN
      END
```

```
C***********************************************************
C                                                          *
C       DATE:  5 DEC 1983                                  *
C       VERSION:  1.0                                      *
C                                                          *
C       NAME:  EVENT                                       *
C       EVENT NUMBER:  N/A                                 *
C       FUNCTION: CALLS DIFFERENT EVENTS ACCORDING TO THE  *
C                 EVENT NUMBER PASSED.                     *
C       FILES READ: NONE.                                  *
C       FILES WRITTEN:  NONE                               *
C       EVENTS CALLED: 1 - 24                              *
C       CALLING EVENTS: ALL                                *
C       SUBROUTINES CALLED:  NONE.                         *
C       CALLING SUBROUTINES:  ALL                          *
C                                                          *
C       AUTHOR:  DAVID L. OWEN                             *
C       HISTORY: N/A                                       *
C                                                          *
C***********************************************************

      SUBROUTINE EVENT(I)
      COMMON/SCOM1/ ATRIB(100),DD(100),DDL(100),DTNOW,II,MFA,MSTOP
     1,NCLNR,NCRDR,NPRNT,NNRUN,NNSET,NTAPE,SS(100)
     1,SSL(100),TNEXT,TNOW,XX(100)

      GO TO (1,2,3,4,5,6,7,8,9,10,11,12,13,14,15,16,17,
     1       18,19,20,21,22,23,24),I

C*** ARRIVAL OF JOB AT CARD READER
1     CALL ARVL
      RETURN

C*** PUT INPUT SPOOLER INTO HOLD QUEUE
2     CALL ISPO
      RETURN

C*** PUT JOB INTO INPUT QUEUE
3     CALL ENT1
      RETURN

C***  PERFORM CPU BURST
4     CALL CPU
      RETURN

C***  LOAD JOB SCHEDULER INTO EXECUTE QUEUE
5     CALL LJSCH
      RETURN

C***  LOAD OUTPUT SPOOLE INTO SYSTEM
```

```
6     CALL LOSPL
      RETURN

C***  USER JOB COMPLETE
7     CALL JCOMP
      RETURN

C***  PERFORM DISK I/O
8     CALL DISKS
      RETURN

C***  PERFORM TAPE I/O
9     CALL TAPES
      RETURN

C***  USER JOB TIME-OUT
10    CALL TIMEO
      RETURN

C***  READ CARDS INTO BUFFER
11    CALL RCARD
      RETURN

C***  DISK TRANFER COMPLETED
12    CALL DCOMP
      RETURN

C***  TAPE I/O COMPLETION
13    CALL TCOMP
      RETURN

C***  FULL BUFFER
14    CALL FULLB
      RETURN

C***  FIND CHANNEL
15    CALL CHANL
      RETURN

C***  DISK/TAPE TRANSFER
16    CALL DTRAN
      RETURN

C***  FINISHED PRINTING BUFFER
17    CALL FPRNT
      RETURN

C***  COMPLETION OF JOB SCHEDULER
18    CALL JSCOM
      RETURN
```

```
C***  WRITE ACCOUNTING DATA TO DISK FILE
19    CALL ACTLG
      RETURN

C***  H/W MONITOR COLLECTION
20    CALL HWMON
      RETURN

C***  LOAD S/W MONITOR INTO HOLD QUEUE
21    CALL LSMON
      RETURN

C***  END OF S/W MONITOR TRACE
22    CALL ESMON
      RETURN

C***  WRITE S/W MONITOR DATA TO DISK
23    CALL SMON
      RETURN

C***  PRINT BUFFER
24    CALL PBUFF
      RETURN

      END
```

```
C***********************************************************
C                                                          *
C       DATE:  5 DEC 1983                                  *
C       VERSION:  1.0                                      *
C                                                          *
C       NAME: ARVL                                         *
C       EVENT NUMBER: 1                                    *
C       FUNCTION:  READS JOBS ATTRIBUTES AND SCHEDULES THE*
C                  THE ARRIVAL TIME OF THE JOB             *
C       FILES READ: WORKDES.                               *
C       FILES WRITTEN:  NONE.                              *
C       EVENTS CALLED: 3                                   *
C       CALLING EVENTS: NONE.                              *
C       SUBROUTINES CALLED: NONE.                          *
C       CALLING SUBROUTINES: NONE.                         *
C                                                          *
C       AUTHOR:  DAVID L. OWEN                             *
C       HISTORY: N/A.                                      *
C                                                          *
C***********************************************************

       SUBROUTINE ARVL
       COMMON/SCOM1/ ATRIB(100),DD(100),DDL(100),DTNOW,II,MFA,MSTOP
     1,NCLNR,NCRDR,NPRNT,NNRUN,NNSET,NTAPE,SS(100)
     1,SSL(100),TNEXT,TNOW,XX(100)
      COMMON/UCOM1/A(100), PART(20,2), TAPE(20,3)
      COMMON/UCOM2/DISK(10,7), DCNT(10), DSTRT(10), DSUM(10),DFIN(10),
     1  CCNT(5), CSUM(5), CFIN(5), CSTRT(5), RCNT,RSTRT,RFIN,RSUM,
     1  PCNT, PSTRT, PFIN, PSUM

C     READ ATRIBUTES FROM WORKLOAD FILE
50    READ (UNIT=11,FMT=1,END=999,ERR=999)(ATRIB(I),I=1,10)
1     FORMAT(12X,F10.4,1X,F10.0,1X,F3.0,1X,F3.0,1X,F2.0,1X,F2.0,
     1    1X,F4.0,1X,F5.0,1X,F4.0,1X,F4.0)


C***  IF THE JOB REQUIRES 0 CPU TIME THEN REJECT JOB
C***    AND READ NEXT JOB'S ATRIBUTES
      IF (ATRIB(3) .LE. 0.0) THEN
        PRINT *,'JOB REJECTED: REQUESTED 0 CPU TIME'
        PRINT *,(ATRIB(I),I=I,21)
        GOTO 50
      END IF

C***  CONVERT HOURS TO SECONDS FOR ARRIVAL TIME
      ATRIB(1) = ATRIB(1) * 3600.

C***  CONVERT CPU TIME TO THE RELATIVE SPEED OF THE CPU
      ATRIB(3) = ATRIB(3) * XX(6)
```

```
C******  CALCULATE OTHER ATRIBUTES

      DO 5 I=11,24
         ATRIB(12) = 0.0
5     CONTINUE
C***  I/O TIME USED = 0

C***  CPU TIME LEFT = CPU TIME REQUIRED
      ATRIB(18) = ATRIB(3)

C***  SET ATRIB(21) TO ARRIVED WHEN S/W MON NOT ON
      ATRIB(21) = 99.

C****  SCHEDULE JOB ARRIVAL AT PROPER TIME
      CALL SCHDL(3,ATRIB(1) - TNOW,ATRIB)

999   RETURN
      END
```

```
C***********************************************************
C                                                          *
C       DATE:  5 DEC 1983                                  *
C       VERSION:  1.0                                      *
C                                                          *
C       NAME:  ISPO                                        *
C       EVENT NUMBER:  2                                   *
C       FUNCTION:  INITIALIZES INPUT SPOOLER AND PUTS      *
C               SPOOLER INTO HOLD QUEUE                    *
C       FILES READ: NONE.                                  *
C       FILES WRITTEN:  NONE.                              *
C       EVENTS CALLED: NONE.                               *
C       CALLING EVENTS: NONE.                              *
C       SUBROUTINES CALLED:  NONE.                         *
C       CALLING SUBROUTINES:  NONE.                        *
C                                                          *
C       AUTHOR:  DAVID L. OWEN                             *
C       HISTORY: N/A.                                      *
C                                                          *
C***********************************************************

       SUBROUTINE ISPO
       COMMON/SCOM1/ ATRIB(100),DD(100),DDL(100),DTNOW,II,MFA
     1,MSTOP,NCLNR,NCRDR,NPRNT,NNRUN,NNSET,NTAPE,SS(100)
     1,SSL(100),TNEXT,TNOW,XX(100)
      COMMON/UCOM1/A(100), PART(20,2), TAPE(20,3)
      COMMON/UCOM2/DISK(10,7), DCNT(10), DSTRT(10), DSUM(10),DFIN(10),
     1  CCNT(5), CSUM(5), CFIN(5), CSTRT(5), RCNT,RSTRT,RFIN,RSUM,
     1  PCNT, PSTRT, PFIN, PSUM

      REAL AA(24)
      PARAMETER (SPLER=2.)

C***  SET ATRIBUTES FOR INPUT SPOOLER

C**   ARRIVAL TIME = TNOW
      AA(1) = TNOW
C**   JOB NAME = 999 (DUMMY NUMBER FOR INPUT SPOOLER)
      AA(2) = 999.
C**   MEMORY SIZE NEEDED IS 4K
      AA(4) = 4.0

C***  SET JOB TYPE TO INPUT SPOOLER
      AA(11) = SPLER

C     CPU TIME USED = TOTAL CPU TIME USED BY INPUT SPOOLER
      AA(12) = XX(40)
C
C***  INITIALIZE OTHER ATRIBUTES TO 0
      AA(3) = 0
      AA(5) = 0
      AA(6) = 0
      AA(7) = 0
      AA(8) = 0
      AA(9) = 0
      AA(10) = 0
      DO 11 I=13,24
        AA(I) = 0
11    CONTINUE

C***  INTITIALIZE ATRIB(21) TO ARRIVED WHEN S/W MON NOT ON
      AA(21) = 99.


C***  PUT INPUT SPOOLER INTO HOLD QUEUE
      CALL ENTER(2,AA)

      RETURN
      END
```

```
C***********************************************************
C                                                          *
C       DATE:  5 DEC 1983                                  *
C       VERSION:  1.0                                      *
C                                                          *
C       NAME: ENT1                                         *
C       EVENT NUMBER: 3                                    *
C       FUNCTION:  ENTERS JOB INTO INPUT QUEUE AND CALLS   *
C            EVENT 1 TO SCHEDULE NEXT JOB                  *
C       FILES READ: NONE.                                  *
C       FILES WRITTEN:  NONE.                              *
C       EVENTS CALLED: 1                                   *
C       CALLING EVENTS: 1                                  *
C       SUBROUTINES CALLED:  NONE.                         *
C       CALLING SUBROUTINES:  NONE.                        *
C                                                          *
C       AUTHOR:  DAVID L. OWEN                             *
C       HISTORY: N/A.                                      *
C                                                          *
C***********************************************************

      SUBROUTINE ENT1
       COMMON/SCOM1/ ATRIB(100),DD(100),DDL(100),DTNOW,II,MFA
     1,MSTOP,NCLNR,NCRDR,NPRNT,NNRUN,NNSET,NTAPE,SS(100)
     1,SSL(100),TNEXT,TNOW,XX(100)
      COMMON/UCOM1/A(100), PART(20,2), TAPE(20,3)
      COMMON/UCOM2/DISK(10,7), DCNT(10), DSTRT(10), DSUM(10),DFIN(10),
     1  CCNT(5), CSUM(5), CFIN(5), CSTRT(5), RCNT,RSTRT,RFIN,RSUM,
     1  PCNT, PSTRT, PFIN, PSUM

C***  PUT JOB INTO INPUT QUEUE
      PRINT *,'NEW USER JOB IN SYSTEM'

C****** PRINT ATRIBUTES FOR DEBUG PURPOSES
      PRINT *,(ATRIB(I),I=1,20)
C
      CALL ENTER(1,ATRIB)

C***  SCHEDULE THE NEXT JOB ARRIVAL BY CALLING ARVL
      CALL SCHDL(1,0)

      RETURN
      END
```

```
C***********************************************************
C                                                          *
C       DATE:  5 DEC 1983                                  *
C       VERSION:  1.0                                      *
C                                                          *
C       NAME:  CPU                                         *
C       EVENT NUMBER:  4                                   *
C       FUNCTION:  DETERMINES WHAT TYPE OF JOB IS GETTING *
C               THE CPU TIME SLICE AND CALLS APPROPRIATE   *
C               ROUTINE TO HANDLE CPU EXECUTION            *
C       FILES READ: NONE.                                  *
C       FILES WRITTEN:  NONE.                              *
C       EVENTS CALLED: NONE.                               *
C       CALLING EVENTS: NONE.                              *
C       SUBROUTINES CALLED:  USER, SPOOL, OSPOL, SSMON,    *
C                       AND JSCHD                          *
C       CALLING SUBROUTINES:  NONE.                        *
C                                                          *
C       AUTHOR:  DAVID L. OWEN                             *
C       HISTORY: N/A.                                      *
C                                                          *
C***********************************************************

      SUBROUTINE CPU
       COMMON/SCOM1/ ATRIB(100),DD(100),DDL(100),DTNOW,II,MFA
     1,MSTOP,NCLNR,NCRDR,NPRNT,NNRUN,NNSET,NTAPE,SS(100)
     1,SSL(100),TNEXT,TNOW,XX(100)
      COMMON/UCOM1/A(100), PART(20,2), TAPE(20,3)
      COMMON/UCOM2/DISK(10,7), DCNT(10), DSTRT(10), DSUM(10),DFIN(10),
     1  CCNT(5), CSUM(5), CFIN(5), CSTRT(5), RCNT,RSTRT,RFIN,RSUM,
     1  PCNT, PSTRT, PFIN, PSUM

      PARAMETER (USR=1.0,SPL=2.0,OSPL=3.0,SWMNT=4.0,JSC=5.0)

C***  CPU-START-TIME = TNOW
      XX(4) = TNOW

C***  IF H/W MONITOR = ON, THEN H/W-MON-CPU-CNT = H/W-MON-CPU-CNT + 1
      IF (XX(30) .EQ. 1) XX(31) = XX(31) + 1

C***  CHECK TO SEE IF JOB TYPE = USER
      IF (ATRIB(11) .EQ. USR) CALL USER

C***  CHECK TO SEE IF JOB TYPE = INPUT SPOOLER
      IF (ATRIB(11) .EQ. SPL) CALL SPOOL

C***  CHECK TO SEE IF JOB TYPE = OUTPUT SPOOLER
      IF (ATRIB(11) .EQ. OSPL) CALL OSPOL

C***  CHECK TO SEE IF JOB TYPE = S/W MONITOR
```

```
      IF (ATRIB(11) .EQ. SWMNT) CALL SSMON

C***  CHECK TO SEE IF JOB TYPE = JOB SCHEDULER
      IF (ATRIB(11) .EQ. JSC) CALL JSCHD

C***  IF JOB .NE. ONE OF THE ABOVE THEN THERE IS AN ERROR
      IF ((ATRIB(11) .GT. 5) .OR. (ATRIB(11) .LT. 1.)) THEN
        PRINT *,'*****************************************'
        PRINT *,'***  ERROR: ILLEGAL JOB TYPE          ***'
        PRINT *,'*****************************************'
        PRINT *,'JOB TYPE = ',ATRIB(11)
      END IF

      RETURN
      END
```

```
C***********************************************************
C                                                          *
C       DATE:  5 DEC 1983                                  *
C       VERSION:  1.0                                      *
C                                                          *
C       NAME:  LJSCH                                       *
C       EVENT NUMBER: 5                                    *
C       FUNCTION:  SETS ATTRIBUTES FOR JOB SCHEDULTER AND  *
C            LOADS JOB INTO HOLD QUEUE                     *
C       FILES READ: NONE.                                  *
C       FILES WRITTEN:  NONE.                              *
C       EVENTS CALLED: NONE.                               *
C       CALLING EVENTS: 7, 12, 17, 22                      *
C       SUBROUTINES CALLED:  NONE.                         *
C       CALLING SUBROUTINES:  NONE.                        *
C                                                          *
C       AUTHOR:  DAVID L. OWEN                             *
C       HISTORY: N/A.                                      *
C                                                          *
C***********************************************************

      SUBROUTINE LJSCH
       COMMON/SCOM1/ ATRIB(100),DD(100),DDL(100),DTNOW,II,MFA
     1,MSTOP,NCLNR,NCRDR,NPRNT,NNRUN,NNSET,NTAPE,SS(100)
     1,SSL(100),TNEXT,TNOW,XX(100)
      COMMON/UCOM1/A(100), PART(20,2), TAPE(20,3)
      COMMON/UCOM2/DISK(10,7), DCNT(10), DSTRT(10), DSUM(10),DFIN(10),
     1  CCNT(5), CSUM(5), CFIN(5), CSTRT(5), RCNT,RSTRT,RFIN,RSUM,
     1  PCNT, PSTRT, PFIN, PSUM

      REAL AAA(24)

C***  PUT JOB SCHEDULER INTO EXECUTE QUEUE
C**   FIRST SET UP ATRIBUTES FOR JOB SCHEDULER
      AAA(1) = TNOW
      AAA(2) = 888
      AAA(11) = 5.
      AAA(12) = XX(42)

      DO 20 III=3,10
20       AAA(III) = 0.

      DO 21 III=13,24
21      AAA(III) = 0.

C***  INITIALIZE ATRIB(21) TO ARRIVED WHILE S/W MON NOT ON
      AAA(21) = 99.

C**   NOW PUT JOB SCHEDULER IN EXECQ
      CALL ENTER(18,AAA)
```

```
C***  SET JSCHED IN EXECQ FLAG TO TRUE
      XX(11) = 1.0

      RETURN
      END
```

```
C***********************************************************
C                                                          *
C       DATE:  5 DEC 1983                                  *
C       VERSION:  1.0                                      *
C                                                          *
C       NAME: LOSPL                                        *
C       EVENT NUMBER: 6                                    *
C       FUNCTION: SETS ATRIBUTES TO OUPUT SPOOLER AND      *
C               LOADS JOB INTO HOLD QUEUE                  *
C       FILES READ: NONE.                                  *
C       FILES WRITTEN:  NONE.                              *
C       EVENTS CALLED: NONE.                               *
C       CALLING EVENTS: NONE.                              *
C       SUBROUTINES CALLED:  NONE.                         *
C       CALLING SUBROUTINES:  NONE.                        *
C                                                          *
C       AUTHOR:  DAVID L. OWEN                             *
C       HISTORY: N/A.                                      *
C                                                          *
C***********************************************************

       SUBROUTINE LOSPL
       COMMON/SCOM1/ ATRIB(100),DD(100),DDL(100),DTNOW,II,MFA
     1,MSTOP,NCLNR,NCRDR,NPRNT,NNRUN,NNSET,NTAPE,SS(100)
     1,SSL(100),TNEXT,TNOW,XX(100)
      COMMON/UCOM1/A(100), PART(20,2), TAPE(20,3)
      COMMON/UCOM2/DISK(10,7), DCNT(10), DSTRT(10), DSUM(10),DFIN(10),
     1  CCNT(5), CSUM(5), CFIN(5), CSTRT(5), RCNT,RSTRT,RFIN,RSUM,
     1  PCNT, PSTRT, PFIN, PSUM

      REAL AA(24)
      PARAMETER (OSPL=3.0,ON=1.0)
C
C***  SET OSPOOLERON FLAG TO ON
      XX(12) = ON

C***  SET ATRIBUTES FOR INPUT SPOOLER
C
C**   ARRIVAL TIME = TNOW
      AA(1) = TNOW
C**   JOB NAME = 998 (DUMMY NUMBER FOR OUTPUT SPOOLER)
      AA(2) = 998.
C**   MEMORY SIZE NEEDED IS 4K
      AA(4) = 4.0
C
C***  SET JOB TYPE TO INPUT SPOOLER
      AA(11) = OSPL
C
C***  SET CPU TIME USED = TOTAL CPU TIME USED BY OUTPUT SPOOLER
      AA(12) = XX(41)
```

```
C
C***  INITIALIZE OTHER ATRIBUTES TO 0
      AA(3) = 0
      AA(5) = 0
      AA(6) = 0
      AA(7) = 0
      AA(8) = 0
      AA(9) = 0
      AA(10) = 0
      DO 11 I=13,24
        AA(I) = 0
11    CONTINUE

C***  INITIALIZE ATRIB(21) TO ARRIVED WHILE S/W MON NOT ON
      AA(21) = 99.

C***  PUT OUTPUT SPOOLER INTO HOLD QUEUE
      CALL ENTER(7,AA)

      RETURN
      END
```

```
C***********************************************************
C                                                          *
C       DATE:  5 DEC 1983                                  *
C       VERSION:  1.0                                      *
C                                                          *
C       NAME: JCOMP                                        *
C       EVENT NUMBER:  7                                   *
C       FUNCTION:  FREES RESOURCES AFTER JOB COMPLETE      *
C       FILES READ: NONE.                                  *
C       FILES WRITTEN:  NONE.                              *
C       EVENTS CALLED: 5                                   *
C       CALLING EVENTS: NONE.                              *
C       SUBROUTINES CALLED:  NONE.                         *
C       CALLING SUBROUTINES:  USER                         *
C                                                          *
C       AUTHOR:  DAVID L. OWEN                             *
C       HISTORY: N/A.                                      *
C                                                          *
C***********************************************************

      SUBROUTINE JCOMP
       COMMON/SCOM1/ ATRIB(100),DD(100),DDL(100),DTNOW,II,MFA
     1,MSTOP,NCLNR,NCRDR,NPRNT,NNRUN,NNSET,NTAPE,SS(100)
     1,SSL(100),TNEXT,TNOW,XX(100)
      COMMON/UCOM1/A(100), PART(20,2), TAPE(20,3)
      COMMON/UCOM2/DISK(10,7), DCNT(10), DSTRT(10), DSUM(10),DFIN(10),
     1  CCNT(5), CSUM(5), CFIN(5), CSTRT(5), RCNT,RSTRT,RFIN,RSUM,
     1  PCNT, PSTRT, PFIN, PSUM

      PARAMETER(FRE=0.0, BUSY=1.0)

C***  CPU-TIME-USED = CPU-TIME USED + (TNOW - CPU-START-TIME)
      ATRIB(12) = ATRIB(12) + (TNOW - XX(4))

C***  MOVE JOB TO OUTPUT QUEUE
      CALL ENTER (10,ATRIB)

C***  FREE CPU, I.E. RELEASE A JOB FROM THE EXECUTE QUEUE
      CALL FREE(3,1)

C***  FIND MEMORY PARTION USED AND FREE IT
      DO 5 III=1,XX(3)
         IF (PART(III,1) .EQ. ATRIB(14)) THEN
           PART(III,2) = FRE
           GOTO 10
         END IF
5     CONTINUE

C***  IF THIS STATEMENT IS REACHED A PARTION WAS NOT FOUND
      PRINT *,'ERROR - UNABLE TO FIND MEMORY PARTION TO FREE'
      PRINT *,'JOB ATRIBUTES ARE'
      PRINT *,(ATRIB(I),I=1,20)
      PRINT *,'MEMORY PARTIONS ARE'
      DO 6 J=1,XX(3)
       PRINT *,PART(J,1),PART(J,2)
6     CONTINUE
      RETURN


C***  FREE TAPES
10    NTAPE = 0
      DO 15 III=1,XX(9)
        IF (TAPE(III,3) .EQ. ATRIB(2)) THEN
           NTAPE = NTAPE + 1
           TAPE(III,2) = FRE
C***       INCREMENT NUMBER OF AVAILABLE TAPE DRIVES
           XX(10) = XX(10) + 1
        END IF
15    CONTINUE

C***  CHECK TO SEE THAT YOU FREE THE RIGHT NUMBER OF TAPES
      IF (NTAPE .NE. NINT(ATRIB(6))) THEN
         PRINT *,'ERROR - FREED ',NTAPE,' TAPES'
         PRINT *,'        SHOULD BE ',ATRIB(6),' TAPES'
      END IF

C***  LOAD JOB SCHEDULER INTO EXECQ IF IT ISN'T ALREADY
      IF (XX(11) .NE. 1.) THEN
        CALL LJSCH
        XX(11) = 1.0
      END IF


      RETURN
      END
```

```
C************************************************************
C                                                           *
C       DATE:  5 DEC 1983                                   *
C       VERSION:  1.0                                       *
C                                                           *
C       NAME: DISKS                                         *
C       EVENT NUMBER:  8                                    *
C       FUNCTION:  FREES CPU, FIGURES OUT WHICH DISK TO     *
C               GO TO AND PUTS JOB INTO DISK QUEUE          *
C       FILES READ: NONE.                                   *
C       FILES WRITTEN:  NONE.                               *
C       EVENTS CALLED: NONE.                                *
C       CALLING EVENTS: NONE.                               *
C       SUBROUTINES CALLED:  NONE.                          *
C       CALLING SUBROUTINES:  SPOOL, OSPOOL, USER           *
C                                                           *
C       AUTHOR:  DAVID L. OWEN                              *
C       HISTORY: N/A.                                       *
C                                                           *
C************************************************************

      SUBROUTINE DISKS
       COMMON/SCOM1/ ATRIB(100),DD(100),DDL(100),DTNOW,II,MFA
     1,MSTOP,NCLNR,NCRDR,NPRNT,NNRUN,NNSET,NTAPE,SS(100)
     1,SSL(100),TNEXT,TNOW,XX(100)
      COMMON/UCOM1/A(100), PART(20,2), TAPE(20,3)
      COMMON/UCOM2/DISK(10,7), DCNT(10), DSTRT(10), DSUM(10),DFIN(10),
     1  CCNT(5), CSUM(5), CFIN(5), CSTRT(5), RCNT,RSTRT,RFIN,RSUM,
     1  PCNT, PSTRT, PFIN, PSUM

      PARAMETER (ON = 1.0)

C***  CALCULATE CPU-TIME-USED AND CPU-TIME-LEFT
      ATRIB(12) = ATRIB(12) + (TNOW - XX(4))
      ATRIB(18) = ATRIB(18) - ((TNOW - XX(4)) * XX(5))

C***  START-I/O = TNOW
      XX(8) = TNOW

C***  FREE CPU
      CALL FREE(3,1)

C***  NEXT DISK = XX(21)
      NDISK = NINT(XX(21))

C***  SET JOB ATRIB(19) TO THE DISK USED
      ATRIB(19) = NDISK + 20

C***  UPDATE NEXT DISK
      IF (XX(21) .GE. XX(22)) THEN
```

```
          XX(21) = 1
       ELSE
          XX(21) = XX(21) + 1
      END IF

C***  AWAIT DISK
      CALL ENTER(23,ATRIB)
      RETURN

      END
```

```
C************************************************************
C                                                           *
C       DATE:  5 DEC 1983                                   *
C       VERSION:  1.0                                       *
C                                                           *
C       NAME: TAPES                                         *
C       EVENT NUMBER:  9                                    *
C       FUNCTION:  FREES CPU, FIGURES OUT WHICH DISK TO     *
C               USE, AND PLACES JOB IN SMALLEST CHAN Q      *
C       FILES READ: NONE.                                   *
C       FILES WRITTEN:  NONE.                               *
C       EVENTS CALLED: NONE.                                *
C       CALLING EVENTS: NONE.                               *
C       SUBROUTINES CALLED:  NONE.                          *
C       CALLING SUBROUTINES:  USER                          *
C                                                           *
C       AUTHOR:  DAVID L. OWEN                              *
C       HISTORY: N/A.                                       *
C                                                           *
C************************************************************

      SUBROUTINE TAPES
       COMMON/SCOM1/ ATRIB(100),DD(100),DDL(100),DTNOW,II,MFA
     1,MSTOP,NCLNR,NCRDR,NPRNT,NNRUN,NNSET,NTAPE,SS(100)
     1,SSL(100),TNEXT,TNOW,XX(100)
      COMMON/UCOM1/A(100), PART(20,2), TAPE(20,3)
      COMMON/UCOM2/DISK(10,7), DCNT(10), DSTRT(10), DSUM(10),DFIN(10),
     1  CCNT(5), CSUM(5), CFIN(5), CSTRT(5), RCNT,RSTRT,RFIN,RSUM,
     1  PCNT, PSTRT, PFIN, PSUM
      COMMON/UCOM3/TAP(10,7), TCNT(10), TSTRT(10), TSUM(10),TFIN(10)


      INTEGER CHL, CHNL

      PARAMETER (ON = 1.0)

C***  CALCULATE CPU-TIME-USED AND CPU-TIME-LEFT
      ATRIB(12) = ATRIB(12) + (TNOW - XX(4))
      ATRIB(18) = ATRIB(18) - ((TNOW - XX(4)) * XX(5))

C***  START-I/O = TNOW
      XX(8) = TNOW

C***  FREE CPU BY RELEASING A JOB FROM THE EXECUTE QUEUE
      CALL FREE(3,1)

C***  FIND NEXT TAPE DRIVE ASSIGNED TO THAT JOB

C**   MAKE SURE YOU DON'T GO INTO INFINITE LOOP
      DO 5 I=1,XX(9)
```

```
          IF (XX(24) .GE. XX(9)) THEN
            XX(24) = 1
           ELSE
            XX(24) = XX(24) + 1.0
          END IF

          NTAPE = NINT(XX(24))

          IF ( TAPE(NTAPE,3) .EQ. ATRIB(2) ) GO TO 10

5       CONTINUE

C***    IF THIS STATEMENT WAS REACHED THEN THEIR ARE NO TAPES ASSIGNED
C***    TO THE JOB
        PRINT *,'ERROR:  TAPES NOT ASSIGNED TO THIS JOB'
        PRINT *,(ATRIB(K),K=1,21)
        RETURN

C***    SET JOB ATRIB(19) TO THE TAPE USED
10      ATRIB(19) = NTAPE + 10

C***    FIND FIRST CHANNEL TAPE IS CONNECTED TO
        DO 1 I=1,XX(23)
           IF (TAP(NTAPE,I) .EQ. 1.0) THEN
              CHNL = I
              CSIZE = NNQ(30 + CHNL)
              ATRIB(20) = CHNL
              GO TO 2
           END IF
1       CONTINUE

C***    IF THIS STATEMENT IS REACHED THEN THE TAPE IS NOT CONNECTED
C***    TO ANY CHANNEL
        PRINT *,'ERROR: TAPE NOT CONNECTED TO ANY CHANNEL'
        PRINT *,'TAPE = ',NTAPE
        PRINT *,'TAPE CHANNELS ARE'
        PRINT *,(TAP(NTAPE,I),I=1,XX(23))
        RETURN

C***    FIND THE SMALLEST CHANNEL QUEUE WHICH THE TAPE CAN USE
2       ICHNL = CHNL
        DO 15 CHL=ICHNL,XX(23)
           IF (TAP(NTAPE,CHL) .EQ. ON) THEN
              IF (NNQ(30+CHL) .LT. CSIZE) THEN
                 CHNL = CHL
                 CSIZE = NNQ(30+CHL)
                 ATRIB(20) = CHNL
              END IF
           END IF
```

```
15    CONTINUE

C***  AWAIT CHANNEL
      CALL ENTER(25,ATRIB)
      RETURN

      END
```

```
C***********************************************************
C                                                          *
C       DATE:  5 DEC 1983                                  *
C       VERSION:  1.0                                      *
C                                                          *
C       NAME: TIMEO                                        *
C       EVENT NUMBER: 10                                   *
C       FUNCTION:  FREES CPU AND PLACES JOB BACK INTO      *
C               EXECUTE QUEUE                              *
C       FILES READ: NONE.                                  *
C       FILES WRITTEN:  NONE.                              *
C       EVENTS CALLED: NONE.                               *
C       CALLING EVENTS: NONE.                              *
C       SUBROUTINES CALLED:  NONE.                         *
C       CALLING SUBROUTINES:  USER                         *
C                                                          *
C       AUTHOR:  DAVID L. OWEN                             *
C       HISTORY: N/A.                                      *
C                                                          *
C***********************************************************

      SUBROUTINE TIMEO
       COMMON/SCOM1/ ATRIB(100),DD(100),DDL(100),DTNOW,II,MFA
     1,MSTOP,NCLNR,NCRDR,NPRNT,NNRUN,NNSET,NTAPE,SS(100)
     1,SSL(100),TNEXT,TNOW,XX(100)
      COMMON/UCOM1/A(100), PART(20,2), TAPE(20,3)
      COMMON/UCOM2/DISK(10,7), DCNT(10), DSTRT(10), DSUM(10),DFIN(10),
     1  CCNT(5), CSUM(5), CFIN(5), CSTRT(5), RCNT,RSTRT,RFIN,RSUM,
     1  PCNT, PSTRT, PFIN, PSUM

C***  CALCULATE CPU-TIME-USED AND CPU-TIME-LEFT
      ATRIB(12) = ATRIB(12) + (TNOW - XX(4))
      ATRIB(18) = ATRIB(18) - ((TNOW - XX(4)) * XX(5))

C***  FREE CPU BY RELEASING A JOB FROM THE EXECUTE QUEUE
      CALL FREE(3,1)

C***  PLACE JOB BACK INTO EXECUTE QUEUE
      CALL ENTER(4,ATRIB)

      RETURN
      END
```

```
C***********************************************************
C                                                          *
C       DATE:  5 DEC 1983                                  *
C       VERSION:  1.0                                      *
C                                                          *
C       NAME:  RCARD                                       *
C       EVENT NUMBER: 11                                   *
C       FUNCTION:  FREES CPU AND READS CARDS INTO BUFFER   *
C       FILES READ: NONE.                                  *
C       FILES WRITTEN:  NONE.                              *
C       EVENTS CALLED: 14                                  *
C       CALLING EVENTS: 16                                 *
C       SUBROUTINES CALLED:  NONE.                         *
C       CALLING SUBROUTINES:  NONE.                        *
C                                                          *
C       AUTHOR:  DAVID L. OWEN                             *
C       HISTORY: N/A.                                      *
C                                                          *
C***********************************************************

      SUBROUTINE RCARD
       COMMON/SCOM1/ ATRIB(100),DD(100),DDL(100),DTNOW,II,MFA
     1,MSTOP,NCLNR,NCRDR,NPRNT,NNRUN,NNSET,NTAPE,SS(100)
     1,SSL(100),TNEXT,TNOW,XX(100)
      COMMON/UCOM1/A(100), PART(20,2), TAPE(20,3)
      COMMON/UCOM2/DISK(10,7), DCNT(10), DSTRT(10), DSUM(10),DFIN(10),
     1  CCNT(5), CSUM(5), CFIN(5), CSTRT(5), RCNT,RSTRT,RFIN,RSUM,
     1  PCNT, PSTRT, PFIN, PSUM

      PARAMETER(ON = 1.0)

C***  UPDATE CPU TIME USED
      ATRIB(12) = ATRIB(12) + (TNOW - XX(4)) * XX(5)

C***  UPDATE NUMBER OF CARDS LEFT TO READ
      IF (ATRIB(7) .LE. XX(20)) THEN
         ATRIB(7) = 0.
       ELSE
         ATRIB(7) = ATRIB(7) - XX(20)
      END IF

C***  FREE CPU
      CALL FREE(3,1)

C***  IF H/W MON IS ON THEN UPDATE READER AND CHANNEL DATA
      IF (XX(30) .EQ. ON) THEN
         RCNT = RCNT + 1
         IF (RSTRT .NE. -1.0) THEN
           IF (RFIN .LT. TNOW) THEN
             RSUM = RSUM + RFIN - RSTRT
```

```
            RSTRT = TNOW
          END IF
         ELSE
          RSTRT = TNOW
        END IF

        RFIN2 = ((XX(20) / XX(18))* 60) + TNOW
        IF (RFIN2 .GE. RFIN) THEN
           RFIN = RFIN2
        END IF

        NCHL = NINT(ATRIB(20))
        IF (CSTRT(NCHL) .NE. -1.0) THEN
          IF (CFIN(NCHL) .LT. TNOW) THEN
            CSUM(NCHL) = CSUM(NCHL) + CFIN(NCHL) - CSTRT(NCHL)
            CSTRT(NCHL) = TNOW
           ELSE
            CCNT(NCHL) = CCNT(NCHL) + 1
          END IF
         ELSE
          CSTRT(NCHL) = TNOW
          CCNT(NCHL) = CCNT(NCHL) + 1
        END IF

        IF (RFIN2 .GT. CFIN(NCHL)) THEN
           CFIN(NCHL) = RFIN2
        END IF
      END IF

C***  SCHEDULE COMPLETION OF LOADING BUFFER
      CALL SCHDL (14,(XX(20) / XX(18)) * 60,ATRIB)

      RETURN
      END
```

```
C*************************************************************
C                                                            *
C       DATE:  5 DEC 1983                                    *
C       VERSION:  1.0                                        *
C                                                            *
C       NAME:  DCOMP                                         *
C       EVENT NUMBER: 12                                     *
C       FUNCTION:  FREES CHANNEL AND DISK AFTER DISK         *
C               TRANSFER.                                    *
C       FILES READ: NONE.                                    *
C       FILES WRITTEN:  NONE.                                *
C       EVENTS CALLED: 5                                     *
C       CALLING EVENTS: 16                                   *
C       SUBROUTINES CALLED:  NONE.                           *
C       CALLING SUBROUTINES:  SPOOL                          *
C                                                            *
C       AUTHOR:  DAVID L. OWEN                               *
C       HISTORY: N/A.                                        *
C                                                            *
C*************************************************************

      SUBROUTINE DCOMP
       COMMON/SCOM1/ ATRIB(100),DD(100),DDL(100),DTNOW,II,MFA
     1,MSTOP,NCLNR,NCRDR,NPRNT,NNRUN,NNSET,NTAPE,SS(100)
     1,SSL(100),TNEXT,TNOW,XX(100)
      COMMON/UCOM1/A(100), PART(20,2), TAPE(20,3)
      COMMON/UCOM2/DISK(10,7), DCNT(10), DSTRT(10), DSUM(10),DFIN(10),
     1  CCNT(5), CSUM(5), CFIN(5), CSTRT(5), RCNT,RSTRT,RFIN,RSUM,
     1  PCNT, PSTRT, PFIN, PSUM

      PARAMETER (ON = 1.0,USR = 1.0,SPL=2.0,OSPL=3.0,FRE=0.0)


C***  FREE CHANNEL OF THE PORTION THAT THE JOB WAS USING
      NCHL = 30 +ATRIB(20)
      ITEMP = NINT(USERF(1))
      CALL FREE(NCHL,ITEMP)

C***  FREE DISK
      NDSK = ATRIB(19)
      CALL FREE(NDSK,1)

C***  UPDATE I/O TIME USED
      ATRIB(13) = ATRIB(13) + (TNOW - XX(8))

C***  IF JOB TYPE = USER
      IF (ATRIB(11) .EQ. USR) THEN
C*       UPDATE TIME OF LAST I/O (CPU-TIM-REQ - CPU-TIM-LEFT)
         ATRIB(16) = ATRIB(3) - ATRIB(18)
C*       PUT JOB BACK INTO EXECUTE QUEUE
```

```
          CALL ENTER(3,ATRIB)
          RETURN
       END IF

C***   IF JOB TYPE IS INPUT SPOOLER
       IF (ATRIB(11) .EQ. SPL) THEN
C**      CHECK FOR COMPLETION OF SPOOLING
         IF (ATRIB(7) .EQ. 0.) THEN
C*          SPOOL STATUS = 0
            XX(15) = 0.0
C******** NEED TO PUT CPU TIME FOR SPOOLER IN HERE

C**         FREE JOB FROM INPUT QUEUE
            CALL FREE(1,1)
            IF (NNQ(1) .NE. 0) THEN
C**            PUT SPOOLER BACK INTO EXECUTE QUEUE
               CALL ENTER(3,ATRIB)
              ELSE
C**            SPOOLERON = 0
               XX(1) = 0
C**           FIND MEMORY PARTION USED AND FREE IT
              DO 5 III=1,XX(3)
                IF (PART(III,1) .EQ. ATRIB(14)) THEN
                   PART(III,2) = FRE
                   GOTO 10
                END IF
5             CONTINUE

C***          IF THIS STMT IS REACHED A PARTION WAS NOT FOUND
              PRINT *,'ERROR - UNABLE TO FIND MEMORY PARTION TO FREE'
              PRINT *,'JOB ATRIBUTES ARE'
              PRINT *,(ATRIB(I),I=1,18)
              PRINT *,'MEMORY PARTIONS ARE'
              DO 6 J=1,XX(3)
                 PRINT *,PART(J,1),PART(J,2)
6             CONTINUE
              RETURN

10            CONTINUE
C***          PUT JOB SCHEDULER INTO EXECQ (IF NOT ALREADY THERE)
              IF (XX(11) .NE. ON) THEN
                 XX(11) = ON
                 CALL SCHDL(5,0.,ATRIB)
              END IF
            END IF
          ELSE
C**         SPOOL STATUS = 2 (READY TO READ MORE CARDS)
            XX(15) = 2.0
C*          PUT SPOOLER BACK INTO EXEC QUEUE
           CALL ENTER(3,ATRIB)
```

```
        END IF
        RETURN
      END IF


C***  IF JOB TYPE IS OUTPUT SPOOLER
      IF (ATRIB(11) .EQ. OSPL) THEN
C**      OSPOOL STATUS = READY TO PRINT BUFFER
         XX(16) = 1.0
C**      PUT OUTPUT SPOOLER BACK INTO EXECQ
         CALL ENTER(3,ATRIB)
         RETURN
      END IF

C***  IF JOB TYPE IS NOT USER OR SPOOLER OR OUTPUT SPOOLER THEN
C***     AN ERROR HAS OCCURRED
      PRINT *,'ERROR: ILLEGAL JOB TYPE IN DCOMP'
      PRINT *,(ATRIB(I),I=1,21)


      RETURN
      END
```

```
C***********************************************************
C                                                          *
C       DATE:  5 DEC 1983                                  *
C       VERSION:  1.0                                      *
C                                                          *
C       NAME:  TCOMP                                       *
C       EVENT NUMBER:  13                                  *
C       FUNCTION:  FREES CHANNEL AFTER TAPE IO COMPLETION  *
C       FILES READ: NONE.                                  *
C       FILES WRITTEN:  NONE.                              *
C       EVENTS CALLED: NONE.                               *
C       CALLING EVENTS: 16                                 *
C       SUBROUTINES CALLED:  USERF                         *
C       CALLING SUBROUTINES:  NONE.                        *
C                                                          *
C       AUTHOR:  DAVID L. OWEN                             *
C       HISTORY: N/A.                                      *
C                                                          *
C***********************************************************

      SUBROUTINE TCOMP
       COMMON/SCOM1/ ATRIB(100),DD(100),DDL(100),DTNOW,II,MFA
     1,MSTOP,NCLNR,NCRDR,NPRNT,NNRUN,NNSET,NTAPE,SS(100)
     1,SSL(100),TNEXT,TNOW,XX(100)
      COMMON/UCOM1/A(100), PART(20,2), TAPE(20,3)
      COMMON/UCOM2/DISK(10,7), DCNT(10), DSTRT(10), DSUM(10),DFIN(10),
     1  CCNT(5), CSUM(5), CFIN(5), CSTRT(5), RCNT,RSTRT,RFIN,RSUM,
     1  PCNT, PSTRT, PFIN, PSUM
      COMMON/UCOM3/TAP(10,7), TCNT(10), TSTRT(10), TSUM(10),TFIN(10)

C*    UPDATE TIME OF LAST TAPE I/O (CPU-TIM-REQ - CPU-TIM-LEFT)
      ATRIB(17) = ATRIB(3) - ATRIB(18)

C***  FREE CHANNEL OF THE PORTION THAT THE JOB WAS USING
      NCHL = 30 + ATRIB(20)
      ITEMP = NINT(USERF(1))
      CALL FREE(NCHL,ITEMP)

C***  UPDATE I/O TIME USED
      ATRIB(13) = ATRIB(13) + (TNOW - XX(8))


C*    PUT JOB BACK INTO EXECUTE QUEUE
      CALL ENTER(3,ATRIB)
      RETURN

      END
```

```
C***********************************************************
C                                                          *
C       DATE:  5 DEC 1983                                  *
C       VERSION:  1.0                                      *
C                                                          *
C       NAME:  CHANL                                       *
C       EVENT NUMBER:  15                                  *
C       FUNCTION:  FINDS SMALLET CHANNEL QUEUE THAT IS     *
C              CONNECT TO DISK, CARD READER, OR PRINTER    *
C       FILES READ: NONE.                                  *
C       FILES WRITTEN:  NONE.                              *
C       EVENTS CALLED: NONE.                               *
C       CALLING EVENTS: 11                                 *
C       SUBROUTINES CALLED:  NONE.                         *
C       CALLING SUBROUTINES:  OSPOL, SPOOL                 *
C                                                          *
C       AUTHOR:  DAVID L. OWEN                             *
C       HISTORY: N/A.                                      *
C                                                          *
C***********************************************************

      SUBROUTINE CHANL
       COMMON/SCOM1/ ATRIB(100),DD(100),DDL(100),DTNOW,II,MFA
     1,MSTOP,NCLNR,NCRDR,NPRNT,NNRUN,NNSET,NTAPE,SS(100)
     1,SSL(100),TNEXT,TNOW,XX(100)
      COMMON/UCOM1/A(100), PART(20,2), TAPE(20,3)
      COMMON/UCOM2/DISK(10,7), DCNT(10), DSTRT(10), DSUM(10),DFIN(10),
     1  CCNT(5), CSUM(5), CFIN(5), CSTRT(5), RCNT,RSTRT,RFIN,RSUM,
     1  PCNT, PSTRT, PFIN, PSUM
      COMMON/UCOM4/CARD(6),PRNTR(6)

      INTEGER CHL, CHNL

      PARAMETER (ON = 1.0, USR=1.0, SPLR=40.0, OSPLR=41.0)

C***  IF IT IS A DISK NEEDING THE CHANNEL
      IF ((ATRIB(19) .GT. 20) .AND. (ATRIB(19) .LE. 30)) THEN


      NDISK = NINT(ATRIB(19) - 20)

C***  FIND FIRST CHANNEL DISK IS CONNECTED TO
      DO 1 I=1,XX(23)
         IF (DISK(NDISK,I) .EQ. 1.0) THEN
            CHNL = I
            CSIZE = NNQ(30 + CHNL)
            ATRIB(20) = CHNL
            GO TO 2
         END IF
1     CONTINUE

C***  IF THIS STATEMENT IS REACHED THEN THE DISK IS NOT CONNECTED
```

```
C***********************************************************
C                                                          *
C       DATE:  5 DEC 1983                                  *
C       VERSION:  1.0                                      *
C                                                          *
C       NAME:  FULLB                                       *
C       EVENT NUMBER:  14                                  *
C       FUNCTION:  FREES CHANNEL AFTER BUFFER HAS BEEN     *
C              LOADED BY CARD READER                       *
C       FILES READ: NONE.                                  *
C       FILES WRITTEN:  NONE.                              *
C       EVENTS CALLED: NONE.                               *
C       CALLING EVENTS: 11                                 *
C       SUBROUTINES CALLED:  USERF                         *
C       CALLING SUBROUTINES:  NONE.                        *
C                                                          *
C       AUTHOR:  DAVID L. OWEN                             *
C       HISTORY: N/A.                                      *
C                                                          *
C***********************************************************

      SUBROUTINE FULLB
       COMMON/SCOM1/ ATRIB(100),DD(100),DDL(100),DTNOW,II,MFA
     1,MSTOP,NCLNR,NCRDR,NPRNT,NNRUN,NNSET,NTAPE,SS(100)
     1,SSL(100),TNEXT,TNOW,XX(100)
      COMMON/UCOM1/A(100), PART(20,2), TAPE(20,3)
      COMMON/UCOM2/DISK(10,7), DCNT(10), DSTRT(10), DSUM(10),DFIN(10),
     1  CCNT(5), CSUM(5), CFIN(5), CSTRT(5), RCNT,RSTRT,RFIN,RSUM,
     1  PCNT, PSTRT, PFIN, PSUM
      COMMON/UCOM4/CARD(6),PRNTR(6)

      PARAMETER (ON=1.0, OFF=0.0, NEW=0.0, BFULL=1.0, BEMPT=2.0)


C***  SET SPOOL-STATUS TO BUFFER FULL
      XX(15) = BFULL

C***  FREE CHANNEL OF THE PORTION THAT THE CARD READER WAS USING
      NCHL = 30 + ATRIB(20)
      ITEMP = USERF(1)
      CALL FREE (NCHL,ITEMP)

C***  PUT SPOOLER BACK INTO EXECUTE QUEUE
      CALL ENTER(3,ATRIB)

      RETURN
      END
```

```
C***  TO ANY CHANNEL
      PRINT *,'ERROR: DISK NOT CONNECTED TO ANY CHANNEL'
      PRINT *,'DISK = ',NDISK
      PRINT *,'DISK CHANNELS ARE'
      PRINT *,(DISK(NDISK,I),I=1,XX(23))
      RETURN

C***  FIND THE SMALLEST CHANNEL QUEUE WHICH THE DISK CAN USE
2     ICHNL = CHNL
      DO 10 CHL=ICHNL,XX(23)
         IF (DISK(NDISK,CHL) .EQ. ON) THEN
            IF (NNQ(30+CHL) .LT. CSIZE) THEN
               CHNL = CHL
               CSIZE = NNQ(30+CHL)
               ATRIB(20) = CHNL
            END IF
         END IF
10    CONTINUE

C***  AWAIT CHANNEL
      CALL ENTER(25,ATRIB)
      RETURN
      END IF


C***  IF IT IS THE CARD READER THAT NEEDS THE CHANNEL
      IF (ATRIB(19) .EQ. SPLR) THEN

      ATRIB(19) = SPLR

C***  FIND FIRST CHANNEL CARD READER IS CONNECTED TO
      DO 4 I=1,XX(23)
         IF (CARD(I) .EQ. 1.0) THEN
            CHNL = I
            CSIZE = NNQ(30 + CHNL)
            ATRIB(20) = CHNL
            GO TO 5
         END IF
4     CONTINUE

C***  IF THIS STATEMENT IS REACHED THEN THE CARD READER IS NOT
C***  CONNECTED TO ANY CHANNEL
      PRINT *,'ERROR: CARD READER NOT CONNECTED TO ANY CHANNEL'
      PRINT *,'CARD READER CHANNELS ARE'
      PRINT *,(CARD(I),I=1,XX(23))
      RETURN

C***  FIND THE SMALLEST CHANNEL QUEUE WHICH THE CARD READER CAN USE
5     ICHNL = CHNL
      DO 6 CHL=ICHNL,XX(23)
         IF (CARD(CHL) .EQ. ON) THEN
            IF (NNQ(30+CHL) .LT. CSIZE) THEN
         DFIN2 = DISK(NDSK,6) + TNOW
         IF (DFIN2 .GE. DFIN(NDSK)) THEN
            DFIN(NDSK) = DFIN2
         END IF

         NCHL = NINT(ATRIB(20))
         IF (CSTRT(NCHL) .NE. -1.0) THEN
           IF (CFIN(NCHL) .LT. TNOW) THEN
             CSUM(NCHL) = CSUM(NCHL) + CFIN(NCHL) - CSTRT(NCHL)
             CSTRT(NCHL) = TNOW
            ELSE
             CCNT(NCHL) = CCNT(NCHL) + 1
           END IF
          ELSE
           CSTRT(NCHL) = TNOW
           CCNT(NCHL) = CCNT(NCHL) + 1
         END IF

         IF (DFIN2 .GT. CFIN(NCHL)) THEN
            CFIN(NCHL) = DFIN2
         END IF
      END IF

C***  SCHEDULE COMPLETION OF DISK TRANSFER
      CALL SCHDL(12,DISK(NDSK,6),ATRIB)

      RETURN
      END IF


C***  IF IT IS A TAPE TRANSFER
      IF ((ATRIB(19) .LE. 20.0) .AND. (ATRIB(19) .GT. 10.)) THEN

      NTAPE = NINT(ATRIB(19) - 10)


C***  IF H/W MON IS ON THEN UPDATE TAPE AND CHANNEL DATA
      IF (XX(30) .EQ. ON) THEN
         TCNT(NTAPE) = TCNT(NTAPE) + 1
         IF (TSTRT(NTAPE) .NE. -1.0) THEN
           IF (TFIN(NTAPE) .LT. TNOW) THEN
             TSUM(NTAPE) = TSUM(NTAPE) + TFIN(NTAPE) - TSTRT(NTAPE)
             TSTRT(NTAPE) = TNOW
           END IF
          ELSE
           TSTRT(NTAPE) = TNOW
         END IF

         TFIN2 = TAP(NTAPE,6) + TNOW
         IF (TFIN2 .GE. TFIN(NTAPE)) THEN
            TFIN(NTAPE) = TFIN2
         END IF

         NCHL = NINT(ATRIB(20))
         IF (CSTRT(NCHL) .NE. -1.0) THEN
           IF (CFIN(NCHL) .LT. TNOW) THEN
             CSUM(NCHL) = CSUM(NCHL) + CFIN(NCHL) - CSTRT(NCHL)
             CSTRT(NCHL) = TNOW
            ELSE
             CCNT(NCHL) = CCNT(NCHL) + 1
           END IF
          ELSE
           CSTRT(NCHL) = TNOW
           CCNT(NCHL) = CCNT(NCHL) + 1
         END IF

         IF (TFIN2 .GT. CFIN(NCHL)) THEN
            CFIN(NCHL) = TFIN2
         END IF
      END IF

C***  SCHEDULE COMPLETION OF TAPE TRANSFER
      CALL SCHDL(13,TAP(NTAPE,6),ATRIB)

      RETURN
      END IF


C***  IF JOB NEEDS TO READ CARDS THEN CALL RCARD
      IF (ATRIB(19) .EQ. SPLR) THEN
         CALL SCHDL(11,0.0,ATRIB)
         RETURN
      END IF


C***  IF JOB NEEDS TO PRINT CALL PBUFF
      IF (ATRIB(19) .EQ. OSPLR) THEN
         CALL SCHDL(24,0.0,ATRIB)
         RETURN
      END IF

      END
```

```
END IF

END
```

```
               CHNL = CHL
               CSIZE = NNQ(30+CHL)
               ATRIB(20) = CHNL
            END IF
         END IF
6     CONTINUE

C***  AWAIT CHANNEL
      CALL ENTER(25,ATRIB)
      RETURN
      END IF




C***  IF IT IS THE LINE PRINTER THAT NEEDS THE CHANNEL
      IF (ATRIB(19) .EQ. OSPLR) THEN

      ATRIB(19) = OSPLR

C***  FIND FIRST CHANNEL LINE PRINTER IS CONNECTED TO
      DO 20 I=1,XX(23)
         IF (PRNTR(I) .EQ. 1.0) THEN
            CHNL = I
            CSIZE = NNQ(30 + CHNL)
            ATRIB(20) = CHNL
            GO TO 25
         END IF
20    CONTINUE

C***  IF THIS STATEMENT IS REACHED THEN THE LINE PRINTER IS NOT
C***  CONNECTED TO ANY CHANNEL
      PRINT *,'ERROR: LINE PRINTER NOT CONNECTED TO ANY CHANNEL'
      PRINT *,'LINE PRINTER CHANNELS ARE'
      PRINT *,(PRNTR(I),I=1,XX(23))
      RETURN

C***  FIND THE SMALLEST CHANNEL QUEUE WHICH THE LINE PRINTER CAN USE
25    ICHNL = CHNL
      DO 30 CHL=ICHNL,XX(23)
         IF (PRNTR(CHL) .EQ. ON) THEN
            IF (NNQ(30+CHL) .LT. CSIZE) THEN
               CHNL = CHL
               CSIZE = NNQ(30+CHL)
               ATRIB(20) = CHNL
            END IF
         END IF
30    CONTINUE

C***  AWAIT CHANNEL
      CALL ENTER(25,ATRIB)
      RETURN
```

```
C************************************************************
C                                                           *
C       DATE:  5 DEC 1983                                   *
C       VERSION:  1.0                                       *
C                                                           *
C       NAME: FPRNT  (FINISHED PRINTING)                    *
C       EVENT NUMBER:  17                                   *
C       FUNCTION:  FREES CHANNEL AFTER PRINTING BUFFER.     *
C               IF THERE IS NO MORE PRINTING TO BE DONE     *
C               THEN THE OUPUT SPOOLER IS RELEASED FROM     *
C               THE SYSTEM , THE PARTITION IS FREED AND     *
C               THE JSCHD IS LOADED.                        *
C       FILES READ: NONE.                                   *
C       FILES WRITTEN:  NONE.                               *
C       EVENTS CALLED: 5                                    *
C       CALLING EVENTS: 24                                  *
C       SUBROUTINES CALLED:  USERF                          *
C       CALLING SUBROUTINES:  NONE.                         *
C                                                           *
C       AUTHOR:  DAVID L. OWEN                              *
C       HISTORY: N/A.                                       *
C                                                           *
C************************************************************

      SUBROUTINE FPRNT
       COMMON/SCOM1/ ATRIB(100),DD(100),DDL(100),DTNOW,II,MFA
     1,MSTOP,NCLNR,NCRDR,NPRNT,NNRUN,NNSET,NTAPE,SS(100)
     1,SSL(100),TNEXT,TNOW,XX(100)
      COMMON/UCOM1/A(100), PART(20,2), TAPE(20,3)
      COMMON/UCOM2/DISK(10,7), DCNT(10), DSTRT(10), DSUM(10),DFIN(10),
     1  CCNT(5), CSUM(5), CFIN(5), CSTRT(5), RCNT,RSTRT,RFIN,RSUM,
     1  PCNT, PSTRT, PFIN, PSUM

      PARAMETER (ON = 1.0,FRE=0.0)


C***  FREE CHANNEL OF THE PORTION THAN THE LINE PRINTER WAS USING
      NCHL = 30 + ATRIB(20)
      ITEMP = USERF(1)
      CALL FREE(NCHL,ITEMP)

C**     CHECK FOR COMPLETION OF OUTPUT SPOOLING
        IF (ATRIB(8) .EQ. 0.) THEN
C*         OSPOOL STATUS = 0
           XX(16) = 0.0
C******** NEED TO PUT CPU TIME FOR SPOOLER IN HERE

C**        FREE JOB FROM OUTPUT QUEUE
           CALL FREE(4,1)
           IF (NNQ(4) .NE. 0) THEN
C**           PUT OUTPUT SPOOLER BACK INTO EXECUTE QUEUE
              CALL ENTER(3,ATRIB)
```

```
               ELSE
C**             OSPOOLERON = 0
                XX(12) = 0.
C**            FIND MEMORY PARTION USED AND FREE IT
               DO 5 III=1,XX(3)
                 IF (PART(III,1) .EQ. ATRIB(14)) THEN
                    PART(III,2) = FRE
                    GOTO 10
                 END IF
5              CONTINUE

C***           IF THIS STMT IS REACHED A PARTION WAS NOT FOUND
               PRINT *,'ERROR - UNABLE TO FIND MEMORY PARTION TO FREE'
               PRINT *,'JOB ATRIBUTES ARE'
               PRINT *,(ATRIB(I),I=1,18)
               PRINT *,'MEMORY PARTIONS ARE'
               DO 6 J=1,XX(3)
                  PRINT *,PART(J,1),PART(J,2)
6              CONTINUE
               RETURN

10             CONTINUE
C***           PUT JOB SCHEDULER INTO EXECQ (IF NOT ALREADY THERE)
               IF (XX(11) .NE. ON) THEN
                  XX(11) = ON
                  CALL SCHDL(5,0.,ATRIB)
               END IF
             END IF
           ELSE
C**          SPOOL STATUS = 2 (READY TO READ MORE CARDS)
             XX(16) = 2.0
C*           PUT SPOOLER BACK INTO EXEC QUEUE
            CALL ENTER(3,ATRIB)
          END IF
          RETURN

        END
```

```
C***********************************************************
C                                                          *
C       DATE:  5 DEC 1983                                  *
C       VERSION:  1.0                                      *
C                                                          *
C       NAME: JSCOM  (JOB SCHED COMPLETION)                *
C       EVENT NUMBER:  18                                  *
C       FUNCTION:  FREES CPU.  SINCE JOB SCHEDULER IS      *
C               ALSO CORE RESIDENT THERE IS NO MEMORY      *
C               PARTITION TO FREE.                         *
C       FILES READ: NONE.                                  *
C       FILES WRITTEN:  NONE.                              *
C       EVENTS CALLED: NONE.                               *
C       CALLING EVENTS: NONE.                              *
C       SUBROUTINES CALLED:  NONE.                         *
C       CALLING SUBROUTINES:  JSCHD                        *
C                                                          *
C       AUTHOR:  DAVID L. OWEN                             *
C       HISTORY: N/A.                                      *
C                                                          *
C***********************************************************

      SUBROUTINE JSCOM
       COMMON/SCOM1/ ATRIB(100),DD(100),DDL(100),DTNOW,II,MFA
     1,MSTOP,NCLNR,NCRDR,NPRNT,NNRUN,NNSET,NTAPE,SS(100)
     1,SSL(100),TNEXT,TNOW,XX(100)

C***  FREE CPU BY RELEASING JOB FROM EXECUTE QUEUE
      CALL FREE(3,1)

C***  UPDATE CPU TIME USED BY JOB SCHEDULER
      XX(42) = XX(42) + (TNOW - XX(4))

      RETURN
      END
```

```
C***********************************************************
C                                                          *
C       DATE:  5 DEC 1983                                  *
C       VERSION:  1.0                                      *
C                                                          *
C       NAME: DTRAN                                        *
C       EVENT NUMBER:  16                                  *
C       FUNCTION:  PERFORMS A DISK OR TAPE TRANSFER IF     *
C               NECESSARY.  IF A CARD IS TO BE READ OR     *
C               A LINE TO PRINTED THEN THE APPROPRIATE     *
C               SUBROUTINE IS CALLED                       *
C       FILES READ: NONE.                                  *
C       FILES WRITTEN:  NONE.                              *
C       EVENTS CALLED: 11, 12, 13, 24                      *
C       CALLING EVENTS: NONE.                              *
C       SUBROUTINES CALLED:  NONE.                         *
C       CALLING SUBROUTINES:  NONE.                        *
C                                                          *
C       AUTHOR:  DAVID L. OWEN                             *
C       HISTORY: N/A.                                      *
C                                                          *
C***********************************************************

      SUBROUTINE DTRAN
       COMMON/SCOM1/ ATRIB(100),DD(100),DDL(100),DTNOW,II,MFA
     1,MSTOP,NCLNR,NCRDR,NPRNT,NNRUN,NNSET,NTAPE,SS(100)
     1,SSL(100),TNEXT,TNOW,XX(100)
      COMMON/UCOM1/A(100), PART(20,2), TAPE(20,3)
      COMMON/UCOM2/DISK(10,7), DCNT(10), DSTRT(10), DSUM(10),DFIN(10),
     1  CCNT(5), CSUM(5), CFIN(5), CSTRT(5), RCNT,RSTRT,RFIN,RSUM,
     1  PCNT, PSTRT, PFIN, PSUM
      COMMON/UCOM3/TAP(10,7), TCNT(10), TSTRT(10), TSUM(10),TFIN(10)
      COMMON/UCOM4/CARD(6),PRNTR(6)

      PARAMETER (ON = 1.0, SPLR=40.0, OSPLR=41.0)

C***  IF IT IS A DISK TRANSFER
      IF ((ATRIB(19) .GE. 21.) .AND. (ATRIB(19) .LE. 30.)) THEN

      NDSK = NINT(ATRIB(19) - 20)

C***  IF H/W MON IS ON THEN UPDATE DISK AND CHANNEL DATA
      IF (XX(30) .EQ. ON) THEN
         DCNT(NDSK) = DCNT(NDSK) + 1
         IF (DSTRT(NDSK) .NE. -1.0) THEN
           IF (DFIN(NDSK) .LT. TNOW) THEN
             DSUM(NDSK) = DSUM(NDSK) + DFIN(NDSK) - DSTRT(NDSK)
             DSTRT(NDSK) = TNOW
           END IF
          ELSE
           DSTRT(NDSK) = TNOW
         END IF
```

```
C**********************************************************
C                                                         *
C       DATE:  5 DEC 1983                                 *
C       VERSION:  1.0                                     *
C                                                         *
C       NAME: ACTLG  (ACTIVITY LOG)                       *
C       EVENT NUMBER:  19                                 *
C       FUNCTION:  WRITE ACOUNTING DATA TO THE ACCOUNTING *
C               LOG                                       *
C       FILES READ: NONE.                                 *
C       FILES WRITTEN:  ACTLOG                            *
C       EVENTS CALLED: NONE.                              *
C       CALLING EVENTS: NONE.                             *
C       SUBROUTINES CALLED:  NONE.                        *
C       CALLING SUBROUTINES:  NONE.                       *
C                                                         *
C       AUTHOR:  DAVID L. OWEN                            *
C       HISTORY: N/A.                                     *
C                                                         *
C**********************************************************

       SUBROUTINE ACTLG
       COMMON/SCOM1/ ATRIB(100),DD(100),DDL(100),DTNOW,II,MFA,MSTOP
     1,NCLNR,NCRDR,NPRNT,NNRUN,NNSET,NTAPE,SS(100)
     1,SSL(100),TNEXT,TNOW,XX(100)
      COMMON/UCOM1/A(100), PART(20,2), TAPE(20,3)
      COMMON/UCOM2/DISK(10,7), DCNT(10), DSTRT(10), DSUM(10),DFIN(10),
     1  CCNT(5), CSUM(5), CFIN(5), CSTRT(5), RCNT,RSTRT,RFIN,RSUM,
     1  PCNT, PSTRT, PFIN, PSUM

C***  SET DEPARTURE TIME TO TNOW
      ATRIB(15) = TNOW

C     WRITE ARRIVAL TIME, JOB NAME, CPU TIME REQUIRED, MEMORY, PRIORITY,
C     ALLOCATABLE DEVIECES NEEDED, CARDS, LINES, DISK BLOCKS,
ALLOCATABLE
C     DEVICE BLOCKS, JOB TYPE, CPU TIME USED, I/O TIME USED, MEMORY SIZE
C     USED, AND DEPARTURE TIME TO THE ACOUNTING DATA FILE

      PRINT *,'**************** WRITING ACT DATA NOW ***********'
      PRINT *,(ATRIB(I),I=1,15)

      WRITE (UNIT=12,FMT=2,ERR=990)(ATRIB(I),I=1,15)
2     FORMAT(1X,F15.4,1X,F10.0,1X,F5.0,1X,F5.0,1X,F5.0,1X,F5.0,
     1    1X,F6.0,1X,F6.0,1X,F6.0,1X,F6.0,1X,F2.0,1X,F10.3,1X,
     1    F10.3,1X,F6.1,1X,F15.4)

      RETURN

990   PRINT *,'ERROR IN WRITING TO ACCOUNTING DATA FILE'

      RETURN
```

END

```
C**********************************************************
C                                                         *
C       DATE:  5 DEC 1983                                 *
C       VERSION:  1.0                                     *
C                                                         *
C       NAME: HWMON  (HARDWARE MONITOR)                   *
C       EVENT NUMBER:  20                                 *
C       FUNCTION:  WRITE HARDWARE MONITOR DATA.  RESECTS  *
C               COUNTERS AND TIMERS. SCHEDULES NEXT TIME  *
C               TO RECORD H/W MONITOR DATA                *
C       FILES READ: NONE.                                 *
C       FILES WRITTEN:  HRDMON                            *
C       EVENTS CALLED: 20                                 *
C       CALLING EVENTS: NONE.                             *
C       SUBROUTINES CALLED:  NONE.                        *
C       CALLING SUBROUTINES:  NONE.                       *
C                                                         *
C       AUTHOR:  DAVID L. OWEN                            *
C       HISTORY: N/A.                                     *
C                                                         *
C**********************************************************

       SUBROUTINE HWMON
       COMMON/SCOM1/ ATRIB(100),DD(100),DDL(100),DTNOW,II,MFA,MSTOP
     1,NCLNR,NCRDR,NPRNT,NNRUN,NNSET,NTAPE,SS(100)
     1,SSL(100),TNEXT,TNOW,XX(100)
      COMMON/UCOM1/A(100), PART(20,2), TAPE(20,3)
      COMMON/UCOM2/DISK(10,7), DCNT(10), DSTRT(10), DSUM(10),DFIN(10),
     1  CCNT(5), CSUM(5), CFIN(5), CSTRT(5), RCNT,RSTRT,RFIN,RSUM,
     1  PCNT, PSTRT, PFIN, PSUM
      COMMON/UCOM3/TAP(10,7), TCNT(10), TSTRT(10), TSUM(10),TFIN(10)
      COMMON/UCOM6/IPROBE(5)

      DIMENSION TIMER(2),ICNTER(3)

      PARAMETER(OFF=0.0, ON=1.0, ST=-1.0)

C***  CHECK TO SEE IF IT TIME TO START H/W MONITOR
      IF (XX(33) .EQ. TNOW) THEN
       PRINT *,'START OF H/W MON'
        XX(30) = ON
C**     INITIALIZE START TIMES, STOP TIMES, COUNTS AND SUMS
        RSTRT = ST
        PSTRT = ST
        XX(36) = ST
        XX(37) = 0.0
        RSUM = 0.0
        PSUM = 0.0
        XX(31) = 0.0
        RCNT = 0.0
        PCNT = 0.0
        XX(37) = 0.0
```

```
            RFIN = 0.0
            PFIN = 0.0
            DO 60 I=1,10
              DSTRT(I) = ST
              TSTRT(I) = ST
              DSUM(I) = 0.0
              TSUM(I) = 0.0
              DFIN(I) = 0.0
              TFIN(I) = 0.0
              DCNT(I) = 0.0
              TCNT(I) = 0.0
60          CONTINUE
            DO 61 I=1,5
              CSTRT(I) = ST
              CSUM(I) = 0.0
              CCNT(I) = 0.0
              CFIN(I) = 0.0
61          CONTINUE

            CALL SCHDL(20,XX(35),ATRIB)
            RETURN
         END IF


C***     IF H/W MON IS ON THEN
         IF (XX(30) .EQ. ON) THEN

C***     CALCULATE CPU TIME
         IF (XX(36) .NE. -1.0) THEN
            IF (XX(37) .GT. TNOW) THEN
              XX(32) = XX(32) + TNOW - XX(36)
              XX(36) = TNOW
            ELSE
              XX(32) = XX(32) + XX(37) - XX(36)
              XX(36) = -1.0
            END IF
         END IF

C***     CALCULATE CARD READER TIME
         IF (RSTRT .NE. -1.0) THEN
            IF (RFIN .GT. TNOW) THEN
              RSUM = RSUM + TNOW - RSTRT
              RSTRT = TNOW
            ELSE
              RSUM = RSUM + RFIN - RSTRT
              RSTRT = -1.0
            END IF
         END IF

C***     CALCULATE LINE PRINTER TIME
         IF (PSTRT .NE. -1.0) THEN
            IF (PFIN .GT. TNOW) THEN
```

```
          PSUM = PSUM + TNOW - PSTRT
          PSTRT = TNOW
        ELSE
          PSUM = PSUM + PFIN - PSTRT
          PSTRT = -1.0
        END IF
      END IF

C***  CALCULATE DISK TIME
      DO 50 I=1,10
      IF (DSTRT(I) .NE. -1.0) THEN
         IF (DFIN(I) .GT. TNOW) THEN
           DSUM(I) = DSUM(I) + TNOW - DSTRT(I)
           DSTRT(I) = TNOW
         ELSE
           DSUM(I) = DSUM(I) + DFIN(I) - DSTRT(I)
           DSTRT(I) = -1.0
         END IF
      END IF
50    CONTINUE

C***  CALCULATE TAPE TIME
      DO 51 I=1,10
      IF (TSTRT(I) .NE. -1.0) THEN
         IF (TFIN(I) .GT. TNOW) THEN
           TSUM(I) = TSUM(I) + TNOW - TSTRT(I)
           TSTRT(I) = TNOW
         ELSE
           TSUM(I) = TSUM(I) + TFIN(I) - TSTRT(I)
           TSTRT(I) = -1.0
         END IF
      END IF
51    CONTINUE

C***  CALCULATE CHANNEL TIME
      DO 52 I=1,5
      IF (CSTRT(I) .NE. -1.0) THEN
         IF (CFIN(I) .GT. TNOW) THEN
           CSUM(I) = CSUM(I) + TNOW - CSTRT(I)
           CSTRT(I) = TNOW
         ELSE
           CSUM(I) = CSUM(I) + CFIN(I) - CSTRT(I)
           CSTRT(I) = -1.0
         END IF
      END IF
52    CONTINUE

C***  GET TIMER VALUES OF TIMER PROBES
      DO 700 I=1,2
        IF (IPROBE(I) .EQ. 1) THEN
           TIMER(I) = XX(31)
           GOTO 700
          END IF
          IF  (IPROBE(I) .EQ. 2) THEN
             TIMER(I) = RSUM
             GOTO 700
          END IF
          IF  ((IPROBE(I) .GE. 11) .AND. (IPROBE(I) .LE. 20)) THEN
             TIMER(I) = TSUM(IPROBE(I)-10)
             GOTO 700
          END IF
          IF ((IPROBE(I) .GE. 21) .AND. (IPROBE(I) .LE. 30)) THEN
             TIMER(I) = DSUM(IPROBE(I)-20)
             GOTO 700
          END IF
          IF ((IPROBE(I) .GE. 31) .AND. (IPROBE(I) .LE. 35)) THEN
             TIMER(I) = CSUM(IPROBE(I)-30)
             GOTO 700
          END IF
C***      IF NONE OF THE ABOVE THEN PROBE NOT CONNECTED
          TIMER(I) = 0.0
700     CONTINUE

C***    GET COUNTER VALUES OF COUNTER PROBES
        DO 710 I=3,5
          K = I - 2
          IF (IPROBE(I) .EQ. 1) THEN
             ICNTER(K) = NINT(XX(32))
             GOTO 710
          END IF
          IF  (IPROBE(I) .EQ. 2) THEN
             ICNTER(K) = NINT(RCNT)
             GOTO 710
          END IF
          IF  ((IPROBE(I) .GE. 11) .AND. (IPROBE(I) .LE. 20)) THEN
             ICNTER(K) = NINT(TCNT(IPROBE(I)-10))
             GOTO 710
          END IF
          IF ((IPROBE(I) .GE. 21) .AND. (IPROBE(I) .LE. 30)) THEN
             ICNTER(K) = NINT(DCNT(IPROBE(I)-20))
             GOTO 710
          END IF
          IF ((IPROBE(I) .GE. 31) .AND. (IPROBE(I) .LE. 35)) THEN
             ICNTER(K) = NINT(CCNT(IPROBE(I)-30))
             GOTO 710
          END IF
C***      IF NONE OF THE ABOVE THEN PROBE NOT CONNECTED
          ICNTER(K) = 0.0
710     CONTINUE


        PRINT *,'******** WRITING HWMON DATA NOW ****************'
        PRINT *,TNOW,TIMER(1),TIMER(2),(ICNTER(I),I=1,3)
```

```
C***  WRITER H/W MONITOR DATA TO DISK
      WRITE(UNIT=13,FMT=3,IOSTAT=IOS,ERR=990)TNOW,TIMER(1),TIMER(2),
     1      (ICNTER(I),I=1,3)

3     FORMAT(1X,F15.4,1X,F8.3,1X,F8.3,1X,I5,1X,I5,1X,I5)


C***  RESET CPU COUNT, AND CPU SUM
      IF (XX(37) .LE. TNOW) THEN
        XX(31) = 0.
      ELSE
         XX(31) = 1.0
      END IF
      XX(32) = 0.

C***  RESET READER COUNT, AND READER SUM
      IF (RFIN .LE. TNOW) THEN
        RCNT = 0.
      ELSE
         RCNT = 1.0
      END IF
      RSUM = 0.

C***  RESET PRINTER COUNT, AND PRINTER SUM
      IF (PFIN .LE. TNOW) THEN
        PCNT = 0.
      ELSE
            PCNT = 1.0
      END IF
      PSUM = 0.

C***  RESET TAPE COUNT, AND TAPE SUM
      DO 12 I=1,10
         IF (TFIN(I) .LE. TNOW) THEN
           TCNT(I) = 0.
         ELSE
            TCNT(I) = 1.0
         END IF
         TSUM(I) = 0.
12    CONTINUE

C***  RESET DISK COUNT, AND DISK SUM
      DO 9 I=1,10
         IF (DFIN(I) .LE. TNOW) THEN
            DCNT(I) = 0.
          ELSE
            DCNT(I) = 1.0
         END IF
         DSUM(I) = 0.
9     CONTINUE

C***  RESET CHANNEL COUNT AND CHANNEL TIME
```

```
      DO 10 I=1,5
        IF (CFIN(I) .LE. TNOW) THEN
          CCNT(I) = 0.
         ELSE
          CCNT(I) = 1.0
        END IF
        CSUM(I) = 0.
10    CONTINUE

C***  CHECK TO SEE IF IT TIME TO TURN OFF THE H/W MON
      IF (XX(34) .LE. TNOW) THEN
        PRINT *,'TURNING OFF H/W MON NOW'
         XX(30) = OFF
         RETURN
       ELSE
C***     SCEDULE NEXT RECORDING OF H/W MONITOR DATA
         CALL SCHDL(20,XX(35),ATRIB)
         RETURN
      END IF

C***  END OF IF H/W MON IS ON
      END IF

      RETURN

990   PRINT *,'ERROR IN WRITING TO H/W MON'
      PRINT *,'IOSTAT = ',IOS
      RETURN

      END
```

```
C***********************************************************
C                                                          *
C       DATE:  5 DEC 1983                                  *
C       VERSION:  1.0                                      *
C                                                          *
C       NAME:  LSMON  (LOAD S/W MONITOR)                   *
C       EVENT NUMBER:  21                                  *
C       FUNCTION:  LOADS S/W MONITOR INTO HOLD QUEUE       *
C       FILES READ: NONE.                                  *
C       FILES WRITTEN:  NONE.                              *
C       EVENTS CALLED: NONE.                               *
C       CALLING EVENTS: NONE.                              *
C       SUBROUTINES CALLED:  NONE.                         *
C       CALLING SUBROUTINES:  INTLC                        *
C                                                          *
C       AUTHOR:  DAVID L. OWEN                             *
C       HISTORY: N/A.                                      *
C                                                          *
C***********************************************************

       SUBROUTINE LSMON
       COMMON/SCOM1/ ATRIB(100),DD(100),DDL(100),DTNOW,II,MFA
     1,MSTOP,NCLNR,NCRDR,NPRNT,NNRUN,NNSET,NTAPE,SS(100)
     1,SSL(100),TNEXT,TNOW,XX(100)
      COMMON/UCOM1/A(100), PART(20,2), TAPE(20,3)
      COMMON/UCOM2/DISK(10,7), DCNT(10), DSTRT(10), DSUM(10),FIN(10),
     1  CCNT(5), CSUM(5), CFIN(5), CSTRT(5), RCNT,RSTRT,RFIN,RSUM,
     1  PCNT, PSTRT, PFIN, PSUM

      REAL AA(24)
      PARAMETER (SWMN=4.0,ON=1.0)

C***  SET ATRIBUTES FOR S/W MONITOR

C**   ARRIVAL TIME = TNOW
      AA(1) = TNOW
C**   JOB NAME = 997 (DUMMY NUMBER FOR S/W MONITOR)
      AA(2) = 997.
C**   MEMORY SIZE NEEDED IS 4K
      AA(4) = 4.0

C***  SET JOB TYPE TO INPUT SPOOLER
      AA(11) = SWMN

C***  INITIALIZE OTHER ATRIBUTES TO 0
      AA(3) = 0
      AA(5) = 0
      AA(6) = 0
      AA(7) = 0
      AA(8) = 0
      AA(9) = 0
      AA(10) = 0
      DO 11 I=12,24
        AA(I) = 0
```

```
11    CONTINUE

C***  INITIALIZE ATRIB(21) TO ARRIVED WHILE S/W MON NOT ON
      AA(21) = 99.

C***  PUT S/W MON INTO HOLD QUEUE
      CALL ENTER(21,AA)

      RETURN
      END
```

```
C***********************************************************
C                                                          *
C       DATE:  5 DEC 1983                                  *
C       VERSION:  1.0                                      *
C                                                          *
C       NAME:  ESMON  (END OF S/W MONITOR TRACE)           *
C       EVENT NUMBER:  22                                  *
C       FUNCTION:  TERMINATES S/W MONITOR TRACE AND FREES *
C               MEMORY PARTITION.  IF NECESSARY IT WILL    *
C               LOAD JOB SCHEDULER.                        *
C       FILES READ: NONE.                                  *
C       FILES WRITTEN:  NONE.                              *
C       EVENTS CALLED: 5                                   *
C       CALLING EVENTS: NONE.                              *
C       SUBROUTINES CALLED:  NONE.                         *
C       CALLING SUBROUTINES:  SSMON                        *
C                                                          *
C       AUTHOR:  DAVID L. OWEN                             *
C       HISTORY: N/A.                                      *
C                                                          *
C***********************************************************

      SUBROUTINE ESMON
       COMMON/SCOM1/ ATRIB(100),DD(100),DDL(100),DTNOW,II,MFA
     1,MSTOP,NCLNR,NCRDR,NPRNT,NNRUN,NNSET,NTAPE,SS(100)
     1,SSL(100),TNEXT,TNOW,XX(100)
      COMMON/UCOM1/A(100), PART(20,2), TAPE(20,3)
      COMMON/UCOM2/DISK(10,7), DCNT(10), DSTRT(10), DSUM(10),DFIN(10),
     1  CCNT(5), CSUM(5), CFIN(5), CSTRT(5), RCNT,RSTRT,RFIN,RSUM,
     1  PCNT, PSTRT, PFIN, PSUM

      PARAMETER(FRE=0.0, BUSY=1.0, OFF=0.0)

      PRINT *,'END OF SOFTWARE MONITOR TRACE'

C***  TURN OFF S/MON ON FLAG
      XX(2) = OFF

C***  SET CPU RATIO BACK TO 100%
      XX(5) = 1.0

C***  FIND MEMORY PARTION USED AND FREE IT
      DO 5 III=1,XX(3)
         IF (PART(III,1) .EQ. ATRIB(14)) THEN
           PART(III,2) = FRE
           GOTO 10
         END IF
5     CONTINUE

C***  IF THIS STATEMENT IS REACHED A PARTION WAS NOT FOUND
      PRINT *,'ERROR - UNABLE TO FIND MEMORY PARTION TO FREE'
      PRINT *,'JOB ATRIBUTES ARE'
      PRINT *,(ATRIB(I),I=1,20)
      PRINT *,'MEMORY PARTIONS ARE'
      DO 6 J=1,XX(3)
       PRINT *,PART(J,1),PART(J,2)
6     CONTINUE
      RETURN

C***  LOAD JOB SCHEDULER INTO EXECQ IF IT ISN'T ALREADY
10    IF (XX(11) .NE. 1.) THEN
        CALL LJSCH
        XX(11) = 1.0
      END IF


      RETURN
      END
```

```
C***********************************************************
C                                                          *
C       DATE:  5 DEC 1983                                  *
C       VERSION:  1.0                                      *
C                                                          *
C       NAME: SMON  (S/W MONITOR)                          *
C       EVENT NUMBER: 23                                   *
C       FUNCTION:  RECORDS S/W MONITOR DATA                *
C       FILES READ: NONE.                                  *
C       FILES WRITTEN:  SFTMON                             *
C       EVENTS CALLED: NONE.                               *
C       CALLING EVENTS: NONE.                              *
C       SUBROUTINES CALLED:  NONE.                         *
C       CALLING SUBROUTINES:  NONE.                        *
C                                                          *
C       AUTHOR:  DAVID L. OWEN                             *
C       HISTORY: N/A.                                      *
C                                                          *
C***********************************************************

      SUBROUTINE SMON
       COMMON/SCOM1/ ATRIB(100),DD(100),DDL(100),DTNOW,II,MFA
     1,MSTOP,NCLNR,NCRDR,NPRNT,NNRUN,NNSET,NTAPE,SS(100)
     1,SSL(100),TNEXT,TNOW,XX(100)
      COMMON/UCOM1/A(100), PART(20,2), TAPE(20,3)
      COMMON/UCOM2/DISK(10,7), DCNT(10), DSTRT(10), DSUM(10),DFIN(10),
     1  CCNT(5), CSUM(5), CFIN(5), CSTRT(5), RCNT,RSTRT,RFIN,RSUM,
     1  PCNT, PSTRT, PFIN, PSUM
      COMMON/UCOM5/IQ(5)

      CHARACTER NAMES(42)*15
      DATA NAMES/'JOB ARRIVAL    ','INPUT QUEUE    ',
     1'HOLD QUEUE     ','EXEC QUEUE     ','OUPUT QUEUE    ',
     1'ARVL SPOOL     ','ARVL OSPOL     ','ARVL S/WMON    ',
     1'ARVL JSCHED    ','JOB FINISHED   ','NOT USED       ',
     1'TAPE 1 QUEUE   ','TAPE 2 QUEUE   ','TAPE 3 QUEUE   ',
     1'TAPE 4 QUEUE   ','TAPE 5 QUEUE   ','TAPE 6 QUEUE   ',
     1'TAPE 7 QUEUE   ','TAPE 8 QUEUE   ','TAPE 9 QUEUE   ',
     1'TAPE 10 QUEUE  ','DISK 1 QUEUE   ','DISK 2 QUEUE   ',
     1'DISK 3 QUEUE   ','DISK 4 QUEUE   ','DISK 5 QUEUE   ',
     1'DISK 6 QUEUE   ','DISK 7 QUEUE   ','DISK 8 QUEUE   ',
     1'DISK 9 QUEUE   ','DISK 10 QUEUE  ','CHAN 1 QUEUE   ',
     1'CHAN 2 QUEUE   ','CHAN 3 QUEUE   ','CHAN 4 QUEUE   ',
     1'CHAN 5 QUEUE   ','CPU            ','GENERAL CHAN   ',
     1'NOT USED       ','NOT USED       ','SPOOL QUEUE    ',
     1'OSPOOL QUEUE   '/

C***  CHECK TO SEE IF IT IS ONE OF THE 5 QUEUES BEING MONITORED
      KQ = NINT(ATRIB(21))
      IF ((KQ .EQ. IQ(1)) .OR. (KQ .EQ. IQ(2)) .OR. (KQ .EQ. IQ(3))
     1   .OR. (KQ .EQ. IQ(4)) .OR. (KQ .EQ.IQ(5))) THEN

C***     CALCULATE TIME IN QUEUE
```

```
         TIME = TNOW - ATRIB(22)

C***  TABLE LOOK UP FOR QUEUE NAMES

C***  CREATE INTEGER INDEXES TO LOOK UP NAMES
C***     NOTE: NEED TO OFFSET BY ONE BECAUSE ARRAY STARTS AT 1 NOT 0
      IQUEUE = NINT(ATRIB(21) + 1)
      IFROM = NINT(ATRIB(23) +1)
      ITO = NINT(ATRIB(24) + 1)

      PRINT *,'WRITING S/W MON DATA NOW'
      PRINT *,'JOB= ',ATRIB(2),' Q= ',NAMES(IQUEUE),' TIME = ',
     1   TIME,' FROM= ',NAMES(IFROM),' TO= ',NAMES(ITO)

         WRITE (UNIT=14,FMT=1,IOSTAT=IOS,ERR=990)NAMES(IQUEUE),TIME,
     1             NAMES(IFROM),NAMES(ITO)

1        FORMAT(1X,A15,1X,F8.3,1X,A15,1X,A15)

      RETURN
      END IF

C*    IN FOR DEBUG ONLY
      IF (ATRIB(21) .EQ. 99.) THEN
      PRINT *,'JOB ENTERED QUEUE BEFORE S/W MON WAS TURNED ON'
       ELSE
      PRINT *,'SWMON NOT MONITORING THIS QUEUE'
      PRINT *,'Q IS ',NAMES(KQ+1)
      END IF
      RETURN

990   PRINT *,'ERROR IN WRITING TO S/W MON DATA FILE'
      PRINT *,'IOSTAT = ',IOS
      RETURN
      END
```

```
C***********************************************************
C                                                          *
C       DATE:  5 DEC 1983                                  *
C       VERSION:  1.0                                      *
C                                                          *
C       NAME: PBUFF  (PRINT BUFFER)                        *
C       EVENT NUMBER: 24                                   *
C       FUNCTION:  PRINTS BUFFER TO LINE PRINTER           *
C       FILES READ: NONE.                                  *
C       FILES WRITTEN:  NONE.                              *
C       EVENTS CALLED: 17                                  *
C       CALLING EVENTS: 16                                 *
C       SUBROUTINES CALLED:  NONE.                         *
C       CALLING SUBROUTINES:  NONE.                        *
C                                                          *
C       AUTHOR:  DAVID L. OWEN                             *
C       HISTORY: N/A.                                      *
C                                                          *
C***********************************************************

      SUBROUTINE PBUFF
       COMMON/SCOM1/ ATRIB(100),DD(100),DDL(100),DTNOW,II,MFA
     1,MSTOP,NCLNR,NCRDR,NPRNT,NNRUN,NNSET,NTAPE,SS(100)
     1,SSL(100),TNEXT,TNOW,XX(100)
      COMMON/UCOM1/A(100), PART(20,2), TAPE(20,3)
      COMMON/UCOM2/DISK(10,7), DCNT(10), DSTRT(10), DSUM(10),DFIN(10),
     1  CCNT(5), CSUM(5), CFIN(5), CSTRT(5), RCNT,RSTRT,RFIN,RSUM,
     1  PCNT, PSTRT, PFIN, PSUM

      PARAMETER(ON= 1.0)

C***  UPDATE CPU TIME USED
      ATRIB(12) = ATRIB(12) + (TNOW - XX(4)) * XX(5)

C***  UPDATE NUMBER OF LINES LEFT TO PRINT
      IF (ATRIB(8) .LE. XX(27)) THEN
         ATRIB(8) = 0.
       ELSE
         ATRIB(8) = ATRIB(8) - XX(27)
      END IF

C***  FREE CPU
      CALL FREE(3,1)

C***  IF H/W MON IS ON THEN UPDATE PRINTER AND CHANNEL DATA
      IF (XX(30) .EQ. ON) THEN
         PCNT = PCNT + 1
         IF (PSTRT .NE. -1.0) THEN
           IF (PFIN .LT. TNOW) THEN
             PSUM = PSUM + PFIN - PSTRT
             PSTRT = TNOW
           END IF
          ELSE
          PSTRT = TNOW
        END IF

        PFIN2 = ((XX(27) / XX(25))* 60) + TNOW
        IF (PFIN2 .GE. PFIN) THEN
           PFIN = PFIN2
        END IF

        NCHL = NINT(ATRIB(20))
        IF (CSTRT(NCHL) .NE. -1.0) THEN
          IF (CFIN(NCHL) .LT. TNOW) THEN
            CSUM(NCHL) = CSUM(NCHL) + CFIN(NCHL) - CSTRT(NCHL)
            CSTRT(NCHL) = TNOW
           ELSE
            CCNT(NCHL) = CCNT(NCHL) + 1
          END IF
         ELSE
          CSTRT(NCHL) = TNOW
          CCNT(NCHL) = CCNT(NCHL) + 1
        END IF

        IF (PFIN2 .GT. CFIN(NCHL)) THEN
           CFIN(NCHL) = PFIN2
        END IF
      END IF

C***  SCHEDULE COMPLETION OF PRINTING BUFFER
      CALL SCHDL (17,(XX(27) / XX(25)) * 60,ATRIB)

      RETURN
      END
```

```
C**********************************************************
C                                                        *
C       DATE:  5 DEC 1983                                *
C       VERSION:  1.0                                    *
C                                                        *
C       NAME: ATAPE  (ASSIGN TAPES)                      *
C       EVENT NUMBER: N/A                                *
C       FUNCTION:  ASSIGNS TAPE DRIVES TO JOB            *
C       FILES READ: NONE.                                *
C       FILES WRITTEN:  NONE.                            *
C       EVENTS CALLED: NONE.                             *
C       CALLING EVENTS: NONE.                            *
C       SUBROUTINES CALLED:  NONE.                       *
C       CALLING SUBROUTINES:  JSCHD                      *
C                                                        *
C       AUTHOR:  DAVID L. OWEN                           *
C       HISTORY: N/A.                                    *
C                                                        *
C**********************************************************

      SUBROUTINE ATAPE
       COMMON/SCOM1/ ATRIB(100),DD(100),DDL(100),DTNOW,II,MFA
     1,MSTOP,NCLNR,NCRDR,NPRNT,NNRUN,NNSET,NTAPE,SS(100)
     1,SSL(100),TNEXT,TNOW,XX(100)
      COMMON/UCOM1/A(100), PART(20,2), TAPE(20,3)
      COMMON/UCOM2/DISK(10,7), DCNT(10), DSTRT(10), DSUM(10),DFIN(10),
     1  CCNT(5), CSUM(5), CFIN(5), CSTRT(5), RCNT,RSTRT,RFIN,RSUM,
     1  PCNT, PSTRT, PFIN, PSUM

      PARAMETER(FREE = 0.0, BUSY = 1.0)

C***  ACQUIRE NUMBER OF TAPES REQUESTED
      DO 10 III=1,A(6)
C**      FIND FREE TAPE
         DO 5 JJJ=1,XX(9)
            IF (TAPE(JJJ,2) .EQ. FREE) THEN
               TAPE(JJJ,2) = BUSY
               TAPE(JJJ,3) = A(2)
C*             DECREMENT NUMBER OF AVAILABLE TAPE DRIVES
               XX(10) = XX(10) - 1
               GOTO 10
            END IF
5        CONTINUE

C     IF THIS STATEMENT IS REACHED THEN TAPES WERE NOT ASSIGNED
      PRINT *,'UNABLE TO ASSIGN TAPES PROPERLY'

10    CONTINUE

      RETURN
      END
```

```
C*********************************************************
C                                                        *
C       DATE:  5 DEC 1983                                *
C       VERSION:  1.0                                    *
C                                                        *
C       NAME: JSCHD  (JOB SCHEDULER)                     *
C       EVENT NUMBER: N/A                                *
C       FUNCTION:  ASSIGNS RESOUCES TO JOBS IN THE HOLD  *
C               QUEUE AND THEN SENDS JOB TO EXECUTER QUEUE*
C       FILES READ: NONE.                                *
C       FILES WRITTEN:  NONE.                            *
C       EVENTS CALLED: 18                                *
C       CALLING EVENTS: 4                                *
C       SUBROUTINES CALLED:  ATAPE                       *
C       CALLING SUBROUTINES:  NONE.                      *
C                                                        *
C       AUTHOR:  DAVID L. OWEN                           *
C       HISTORY: N/A.                                    *
C                                                        *
C*********************************************************

      SUBROUTINE JSCHD
       COMMON/SCOM1/ ATRIB(100),DD(100),DDL(100),DTNOW,II,MFA
     1,MSTOP,NCLNR,NCRDR,NPRNT,NNRUN,NNSET,NTAPE,SS(100)
     1,SSL(100),TNEXT,TNOW,XX(100)
      COMMON/UCOM1/A(100), PART(20,2), TAPE(20,3)
      COMMON/UCOM2/DISK(10,7), DCNT(10), DSTRT(10), DSUM(10),DFIN(10),
     1  CCNT(5), CSUM(5), CFIN(5), CSTRT(5), RCNT,RSTRT,RFIN,RSUM,
     1  PCNT, PSTRT, PFIN, PSUM

      PARAMETER(ON = 1.0, FREE=0.0, BUSY=1.0)

C***  PRINT JOB SCHEDULER STARTED
CXXXXXPRINT *,'JOB SCHEDULER IS NOW EXECUTING'
C***  PRINT MEMORY PARTIONS
CXXXXXPRINT *,'MEMORY PARTIONS ARE'
CXXXXXPRINT *,(PART(I,1),PART(I,2),I=1,XX(3))
CXXXXXPRINT *,'TAPES ARE'
CXXXXXPRINT *,(TAPE(I,1),TAPE(I,2),TAPE(I,3),I=1,XX(9))
C
C***  FOR I = 1, NUM-IN-HOLD QUEUE DO
      III = 1
15    IF (NNQ(2) .EQ. 0) GOTO 10
        IF (III .GT. NNQ(2)) GOTO 10

C***  COPY THE ATRIBUTES OF THE JOB
        CALL COPY(III,2,A)

C***  PRINT WHAT JOB LOOKING AT FOR DEBUG PURPOSES
CXXXXXPRINT *,'TRYING TO FIND RESOURCES FOR:'
CXXXXXPRINT *,(A(K),K=1,20)
```

```
C**     WHILE JJJ .LE. NUM-OF-PARTIONS
        DO 5 JJJ=1,XX(3)

C*        CHECK TO SEE IF PARTION IS LARGE ENOUGH AND FREE
          IF ((PART(JJJ,1) .GE. A(4)) .AND.
     1       (PART(JJJ,2) .EQ. FREE)) THEN
C
CXXXXXPRINT *,'PARTION ',JJJ, ' IS GOOD'
C
C*           CHECK TO SEE IF ENOUGH TAPE DRIVES ARE AVAILABLE
             IF (XX(10) .GE. A(6)) THEN
CXXXXXPRINT *,'ENOUGH TAPES, ACQUIRE RESOURCES'
C*              GET JOB FROM HOLD QUEUE
                CALL RMOVE(III,2,A)
C               ACQUIRE MEMORY PARTITION
C***            PRINT WHAT PARTION USED FOR DEBUG
CXXXXXPRINT *,'PARTION ',JJJ,'USED'
                PART(JJJ,2) = BUSY
C               MEMORY-SIZED-USED = PARTION SIZE
                A(14) = PART(JJJ,1)
C               ACQUIRE TAPES
                CALL ATAPE
C***            PUT JOB INTO EXEC QUEUE
                CALL FILEM(5,A)

C***  PRINT MEMORY PARTIONS
CXXXXXPRINT *,'MEMORY PARTIONS ARE'
CXXXXXPRINT *,(PART(I,1),PART(I,2),I=1,XX(3))
CXXXXXPRINT *,'TAPES ARE'
CXXXXXPRINT *,(TAPE(I,1),TAPE(I,2),TAPE(I,3),I=1,XX(9))

C*              FOUND RESOURCES SO GO TO NEXT JOB IN HOLD QUEUE
                GOTO 15
             END IF

          END IF
C
5       CONTINUE

C***  THIS STATEMENT REACHED ONLY IF JOB NOT ALLOCATED
C***    IF JOB NOT ALLOCATABLE THEN WRITE SO
CXXXXXPRINT *,'JOB NOT ALLOCATED'
C***    INCREMENT POINTER IN HOLDQ
        III = III + 1
C***    GO BACK AND CHECK NEXT JOB
        GOTO 15

10    CONTINUE

C***  IF H/W MON = ON, THEN COLLECT TIMER DATA
      IF (XX(30) .EQ. ON) THEN
         IF (XX(36) .NE. -1.0) THEN
           IF (XX(37) .LT. TNOW) THEN
```

```
               XX(32) = XX(32) + XX(37) - XX(36)
               XX(36) = TNOW
             END IF
            ELSE
             XX(36) = TNOW
           END IF

           UFIN2 = XX(13) + TNOW
           IF (UFIN2 .GE. XX(37)) THEN
              XX(37) = UFIN2
           END IF

        END IF

C
C***    SET JSCHED IN EXECQ FLAG TO FALSE
        XX(11) = 0.
C
C***    SCHEDULE COMPLETION OF JOB SCHEDULER
        CALL SCHDL(18,XX(13),ATRIB)
C
        RETURN
        END
```

```
C***********************************************************
C                                                          *
C       DATE:  5 DEC 1983                                  *
C       VERSION:  1.0                                      *
C                                                          *
C       NAME: OSPOL  (OUTPUT SPOOLER)                      *
C       EVENT NUMBER: N/A                                  *
C       FUNCTION:  SPOOLS JOB ON DISK TO THE PRINTER       *
C       FILES READ: NONE.                                  *
C       FILES WRITTEN:  NONE.                              *
C       EVENTS CALLED: 8, 15                               *
C       CALLING EVENTS: 4                                  *
C       SUBROUTINES CALLED:  NONE.                         *
C       CALLING SUBROUTINES:  NONE.                        *
C                                                          *
C       AUTHOR:  DAVID L. OWEN                             *
C       HISTORY: N/A.                                      *
C                                                          *
C***********************************************************

      SUBROUTINE OSPOL
       COMMON/SCOM1/ ATRIB(100),DD(100),DDL(100),DTNOW,II,MFA
     1,MSTOP,NCLNR,NCRDR,NPRNT,NNRUN,NNSET,NTAPE,SS(100)
     1,SSL(100),TNEXT,TNOW,XX(100)
      COMMON/UCOM1/A(100), PART(20,2), TAPE(20,3)
      COMMON/UCOM2/DISK(10,7), DCNT(10), DSTRT(10), DSUM(10),DFIN(10),
     1  CCNT(5), CSUM(5), CFIN(5), CSTRT(5), RCNT,RSTRT,RFIN,RSUM,
     1  PCNT, PSTRT, PFIN, PSUM

      PARAMETER (OSPLR=41.0,ON=1.0,OFF=0.0,NEW=0.0,BFULL=1.0,BEMPT=2.0)

C***  IF H/W MON IS ON THEN COLLECT CPU TIMER DATA
      IF (XX(30) .EQ. ON) THEN
         IF (XX(36) .NE. -1.0) THEN
           IF (XX(37) .LT. TNOW) THEN
             XX(32) = XX(32) + XX(37) - XX(36)
             XX(36) = TNOW
           END IF
          ELSE
           XX(36) = TNOW
         END IF

         UFIN2 = XX(14) + TNOW
         IF (UFIN2 .GE. XX(37)) THEN
            XX(37) = UFIN2
         END IF

      END IF

C***  IF START OF NEW JOB SPOOLING
      IF (XX(16) .EQ. NEW) THEN
         IF (NNQ(4) .NE. 0) THEN
```

```
            CALL COPY(1,4,A)

C***        SET NUM-LINES IN INPUT SPOOLER ATRIB = JOB'S NUM-CARDS
            ATRIB(8) = A(8)

C***        SCHEDULE CPU COMPLETION, THEN LOAD BUFFER FROM DISK
            CALL SCHDL(8,XX(14),ATRIB)
            RETURN
          END IF
      END IF

C***  IF BUFFER IS FULL
      IF (XX(16) .EQ. BFULL) THEN
C***       SET ATRIB(19) TO LINE PRINTER
           ATRIB(19) = OSPLR
C***      ACQUIRE CHANNEL FOR CARD READER PRIOR TO PRINTING
          CALL SCHDL(15,XX(14),ATRIB)
          RETURN
      END IF

C***  IF BUFFER IS EMPTY
      IF (XX(16) .EQ. BEMPT) THEN
C***      SCHEDULE CPU COMPLETION THEN LOAD BUFFER FROM DISK
          CALL SCHDL(8,XX(14),ATRIB)
          RETURN
      END IF

      RETURN
      END
```

```
C***********************************************************
C                                                          *
C       DATE:  5 DEC 1983                                  *
C       VERSION:  1.0                                      *
C                                                          *
C       NAME: SPOOL  (INPUT SPOOLER)                       *
C       EVENT NUMBER: N/A                                  *
C       FUNCTION:  SPOOLS JOB ON TO DISK FROM THE READER   *
C       FILES READ: NONE.                                  *
C       FILES WRITTEN:  NONE.                              *
C       EVENTS CALLED: 8, 15                               *
C       CALLING EVENTS: 4                                  *
C       SUBROUTINES CALLED:  NONE.                         *
C       CALLING SUBROUTINES:  NONE.                        *
C                                                          *
C       AUTHOR:  DAVID L. OWEN                             *
C       HISTORY: N/A.                                      *
C                                                          *
C***********************************************************

      SUBROUTINE SPOOL
       COMMON/SCOM1/ ATRIB(100),DD(100),DDL(100),DTNOW,II,MFA
     1,MSTOP,NCLNR,NCRDR,NPRNT,NNRUN,NNSET,NTAPE,SS(100)
     1,SSL(100),TNEXT,TNOW,XX(100)
      COMMON/UCOM1/A(100), PART(20,2), TAPE(20,3)
      COMMON/UCOM2/DISK(10,7), DCNT(10), DSTRT(10), DSUM(10),DFIN(10),
     1  CCNT(5), CSUM(5), CFIN(5), CSTRT(5), RCNT,RSTRT,RFIN,RSUM,
     1  PCNT, PSTRT, PFIN, PSUM
      COMMON/UCOM4/CARD(6),PRNTR(6)

      PARAMETER (SPLR=40.0,ON=1.0,OFF=0.0,NEW=0.0,BFULL=1.0,BEMPT=2.0)

C***  COLLECT CPU TIMER DATA FOR H/W MONITOR
      IF (XX(30) .EQ. ON) THEN
         IF (XX(36) .NE. -1.0) THEN
           IF (XX(37) .LT. TNOW) THEN
             XX(32) = XX(32) + XX(37) - XX(36)
             XX(36) = TNOW
           END IF
          ELSE
           XX(36) = TNOW
         END IF

         UFIN2 = XX(14) + TNOW
         IF (UFIN2 .GE. XX(37)) THEN
            XX(37) = UFIN2
         END IF

      END IF


C***  IF START OF NEW JOB SPOOLING
      IF (XX(15) .EQ. NEW) THEN
```

```
          IF (NNQ(1) .NE. 0) THEN
C***        ACQUIRE CARD READER ???????????

            CALL COPY(1,1,A)
            PRINT *,'SPOOLING NEW JOB'
            PRINT *,(A(I),I=1,21)

C***        SET NUM-CARDS IN INPUT SPOOLER ATRIB = JOB'S NUM-CARDS
            ATRIB(7) = A(7)

C***        SET ATRIB(19) TO CARD READER
            ATRIB(19) = SPLR

C***        SCHEDULE CPU TIME OF CPU COMPLETION, THEN ACQUIRE CHANNEL
            CALL SCHDL(15,XX(14),ATRIB)
            RETURN
          END IF
        END IF

C***    IF BUFFER IS FULL
        IF (XX(15) .EQ. BFULL) THEN
C***      SCHEDULE CPU COPMLETION THEN DO I/O
          CALL SCHDL(8,XX(14),ATRIB)
          RETURN
        END IF

C***    IF BUFFER IS EMPTY
        IF (XX(15) .EQ. BEMPT) THEN
C***      SET ATRIB(19) TO CARD READER
          ATRIB(19) = SPLR
C***      SCHEDULE CPU COMPLETION THEN GET CHANNEL
          CALL SCHDL(15,XX(14),ATRIB)
          RETURN
        END IF

        RETURN
        END
```

```
C***********************************************************
C                                                          *
C       DATE:  5 DEC 1983                                  *
C       VERSION:  1.0                                      *
C                                                          *
C       NAME: SSMON  (START S/W MONITOR TRACE)             *
C       EVENT NUMBER: N/A                                  *
C       FUNCTION:  FREES CPU AND STARTS S/W MONITOR TRACE *
C       FILES READ: NONE.                                  *
C       FILES WRITTEN:  NONE.                              *
C       EVENTS CALLED: 22                                  *
C       CALLING EVENTS: 4                                  *
C       SUBROUTINES CALLED:  NONE.                         *
C       CALLING SUBROUTINES:  NONE.                        *
C                                                          *
C       AUTHOR:  DAVID L. OWEN                             *
C       HISTORY: N/A.                                      *
C                                                          *
C***********************************************************

      SUBROUTINE SSMON
       COMMON/SCOM1/ ATRIB(100),DD(100),DDL(100),DTNOW,II,MFA
     1,MSTOP,NCLNR,NCRDR,NPRNT,NNRUN,NNSET,NTAPE,SS(100)
     1,SSL(100),TNEXT,TNOW,XX(100)

      PARAMETER (ON=1.0)

      PRINT *,'*** START OF SOFTWARE MONITOR TRACE'

C***  TURN S/W MON ON FLAG TO ON
      XX(2) = ON

C***  SET THE CPU RATIO TO 95% OF ITS PRESENT SPEED
      XX(5) = .95

C***  FREE CPU
      CALL FREE(3,1)

C***  SCHEDULE END OF S/W MONITOR TRACE
      CALL SCHDL(22,XX(44)-TNOW,ATRIB)

      RETURN
      END
```

```
C**********************************************************
C                                                         *
C      DATE:  5 DEC 1983                                  *
C      VERSION:  1.0                                      *
C                                                         *
C      NAME: USER  (USER CPU BURST)                       *
C      EVENT NUMBER: N/A                                  *
C      FUNCTION:  PERFORMS A TIME BURST ON A USER JOB.    *
C              CALCULATES ENDING TIME OF BURST.           *
C              DETERMINES WHY BURST ENDED AND CALLS       *
C              APPROPRIATE ROUTINE.                       *
C      FILES READ: NONE.                                  *
C      FILES WRITTEN:  NONE.                              *
C      EVENTS CALLED: 7, 8, 9, 10                         *
C      CALLING EVENTS: 4                                  *
C      SUBROUTINES CALLED:  NONE.                         *
C      CALLING SUBROUTINES:  NONE.                        *
C                                                         *
C      AUTHOR:  DAVID L. OWEN                             *
C      HISTORY: N/A.                                      *
C                                                         *
C**********************************************************

      SUBROUTINE USER
       COMMON/SCOM1/ ATRIB(100),DD(100),DDL(100),DTNOW,II,MFA
     1,MSTOP,NCLNR,NCRDR,NPRNT,NNRUN,NNSET,NTAPE,SS(100)
     1,SSL(100),TNEXT,TNOW,XX(100)
      COMMON/UCOM1/A(100), PART(20,2), TAPE(20,3)
      COMMON/UCOM2/DISK(10,7), DCNT(10), DSTRT(10), DSUM(10),DFIN(10),
     1  CCNT(5), CSUM(5), CFIN(5), CSTRT(5), RCNT,RSTRT,RFIN,RSUM,
     1  PCNT, PSTRT, PFIN, PSUM

      PARAMETER(ON = 1.0)

      REAL IOTIM


C***  CALCULATE INTERMEDIATE VARIABLES I/O-TIME, TAPE-TIME, CPU-TIM-LEFT
C***  JOB-COMPLETE-TIME, AND TIME-OUT-TIME
C**    IOTIM = TIME OF NEXT DISK I/O
C**    TTIME = TIME OF NEXT TAPE I/O
C**    CTIME = TIME WHEN JOB WOULD BE COMPLETED IF NO I/OS OR TIMEOUTS
C**    TIMEO = TIME WHEN TIME SLICE WOULD BE OVER
C**    CTU = CPU TIME LEFT

C***  CPU-TIM-USED = CPU-TIME-REQUIRED - CPU-TIME-LEFT
C***    THIS IS DIFFERENT FROM ATRIB(12) BECAUSE ATRIB(12) INCLUDES
C***    SPOOLER CPU TIME AND I/O CPU TIME
      CTU = ATRIB(3) - ATRIB(18)

C***  CHECK TO MAKE SURE YOU DON'T DIVIDE BY 0 FIRST
      IF (ATRIB(9) .NE. 0) THEN
C***    I/O-TIME= TIME-LAST-IO + TIME-BETWEEN - (ROUND OFF ERROR)
```

```
        IOTIM = ATRIB(16) + (ATRIB(3) / ATRIB(9)) - .0000000001
      ELSE
        IOTIM = 9999999.
      END IF

      IF (ATRIB(10) .NE. 0) THEN
C***    TAPE-TIME = TIME-LAST-TAPE + TIME-BETWEEN-TAPE - (ROUND OFF ERR)
        TTIME = ATRIB(17) + (ATRIB(3) / ATRIB(10)) - .0000000001
      ELSE
        TTIME = 9999999.
      END IF

C***  JOB COMPLETE TIME = TNOW + CPU-TIME-LEFT
      CTIME = CTU + (ATRIB(18) / XX(5))

C***  TIME-OUT-TIME = TNOW + TIME-SLICE
      TIMEO = CTU + XX(7)

C****************************************************
C***  CHECK FOR DISK I/O

C**    IF I/O TIME LESS THAN TAPE, JOB COMPLETE AND TIME OUT THEN
      IF ((IOTIM .LE. TTIME) .AND. (IOTIM .LT. CTIME) .AND.
     1     (IOTIM .LE. TIMEO)) THEN

C**       SCHEDULE TIME OF DISK REQUEST
          CALL SCHDL (8,(IOTIM - CTU),ATRIB)
C**       IF H/W MON = ON, THEN COLLECT TIMER DATA
          IF (XX(30) .EQ. ON) THEN
             IF (XX(36) .NE. -1.0) THEN
               IF (XX(37) .LT. TNOW) THEN
                 XX(32) = XX(32) + XX(37) - XX(36)
                 XX(36) = TNOW
               END IF
              ELSE
              XX(36) = TNOW
             END IF

             UFIN2 = (IOTIM - CTU) + TNOW
             IF (UFIN2 .GE. XX(37)) THEN
                XX(37) = UFIN2
             END IF

          END IF

          RETURN
      END IF

C*********************************************************
C***  CHECK FOR TAPE I/O

      IF ((TTIME .LE. CTIME) .AND. (TTIME .LE. TIMEO)) THEN
```

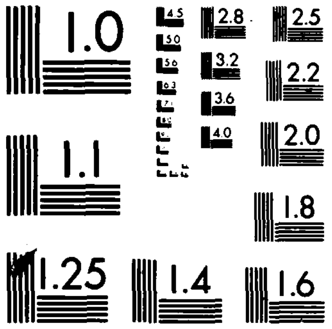
```
C**      SCHEDULE TIME OF TAPE REQUEST
         CALL SCHDL (9,(TTIME - CTU),ATRIB)
C**      IF H/W MON = ON THEN COLLECT TIMER DATA
         IF (XX(30) .EQ. ON) THEN
            IF (XX(36) .NE. -1.0) THEN
              IF (XX(37) .LT. TNOW) THEN
                XX(32) = XX(32) + XX(37) - XX(36)
                XX(36) = TNOW
              END IF
             ELSE
              XX(36) = TNOW
            END IF

            UFIN2 = TTIME - CTU + TNOW
            IF (UFIN2 .GE. XX(37)) THEN
               XX(37) = UFIN2
            END IF

         END IF

         RETURN
      END IF

C************************************************************
C***  CHECK FOR JOB COMPLETE

      IF (CTIME  LE. TIMEO) THEN

      PRINT *,'USER JOB WILL BE COMPLETED WITH THIS BURST'

C***  SCHEDULE COMPLETION OF JOB
      CALL SCHDL(7,(ATRIB(18) / XX(5)),ATRIB)

C**     IF H/W MONITOR = ON, THEN COLLECT H/W MONITOR DATA
C**      IF H/W MON = ON THEN COLLECT TIMER DATA
         IF (XX(30) .EQ. ON) THEN
            IF (XX(36) .NE. -1.0) THEN
              IF (XX(37) .LT. TNOW) THEN
                XX(32) = XX(32) + XX(37) - XX(36)
                XX(36) = TNOW
              END IF
             ELSE
              XX(36) = TNOW
            END IF

            UFIN2 = (ATRIB(18) / XX(5)) + TNOW
            IF (UFIN2 .GE. XX(37)) THEN
               XX(37) = UFIN2
            END IF

         END IF

      RETURN
      END IF

C*********************************************
C***  TIME OUT

C***  IF IT IS NONE OF THE ABOVE CONDITIONS IT MUST BE A TIME-OUT

C**   SCHEDULE TIME-OUT
      CALL SCHDL (10,XX(7),ATRIB)

C***  IF H/W MON IS ON THEN COLLECT CPU TIMER DATA
      IF (XX(30) .EQ. ON) THEN
         IF (XX(36) .NE. -1.0) THEN
           IF (XX(37) .LT. TNOW) THEN
             XX(32) = XX(32) + XX(37) - XX(36)
             XX(36) = TNOW
           END IF
          ELSE
           XX(36) = TNOW
         END IF

         UFIN2 = XX(7) + TNOW
         IF (UFIN2 .GE. XX(37)) THEN
            XX(37) = UFIN2
         END IF

      END IF

      RETURN


      END
```

```
C**********************************************************
C                                                         *
C       DATE:  5 DEC 1983                                 *
C       VERSION:  1.0                                     *
C                                                         *
C       NAME: USERF (USER FUNCTION)                       *
C       EVENT NUMBER: N/A                                 *
C       FUNCTION:  CALCULATES THE PORTION OF THE CHANNEL  *
C               THAT THE PARTICULAR I/O DEVICES IS USING. *
C       FILES READ: NONE.                                 *
C       FILES WRITTEN:  NONE.                             *
C       EVENTS CALLED:  NONE.                             *
C       CALLING EVENTS:  13, 14, 17                       *
C       SUBROUTINES CALLED:  NONE.                        *
C       CALLING SUBROUTINES:  NONE.                       *
C                                                         *
C       AUTHOR:  DAVID L. OWEN                            *
C       HISTORY: N/A.                                     *
C                                                         *
C**********************************************************

      FUNCTION USERF(I)
       COMMON/SCOM1/ ATRIB(100),DD(100),DDL(100),DTNOW,II,MFA
     1,MSTOP,NCLNR,NCRDR,NPRNT,NNRUN,NNSET,NTAPE,SS(100)
     1,SSL(100),TNEXT,TNOW,XX(100)
      COMMON/UCOM1/A(100), PART(20,2), TAPE(20,3)
      COMMON/UCOM2/DISK(10,7), DCNT(10), DSTRT(10), DSUM(10),DFIN(10),
     1  CCNT(5), CSUM(5), CFIN(5), CSTRT(5), RCNT,RSTRT,RFIN,RSUM,
     1  PCNT, PSTRT, PFIN, PSUM
      COMMON/UCOM3/TAP(10,7), TCNT(10), TSTRT(10), TSUM(10),TFIN(10)
      COMMON/UCOM4/CARD(6), PRNTR(6)

      PARAMETER (SPLR = 40.0, OSPLR = 41.0)

C***  IF IT IS A TAPE USING THE CHANNEL
      IF ((ATRIB(19) .GE. 11.) .AND. (ATRIB(19) .LE. 20.)) THEN
         J = ATRIB(19) - 10

C***    CALCULATE THE PORTION OF THE CHANNEL THE TAPE IS USING
        IF ((J .GE. 1) .AND. (J .LE. XX(9))) THEN
           USERF = NINT(1 / TAP(J,6))
        ELSE
          PRINT *,'ERROR : ILLEGAL TAPE'
          PRINT *,(ATRIB(K),K=1,20)
        END IF
        RETURN
      END IF

C***  IF IS A DISK USING THE CHANNEL
      IF ((ATRIB(19) .GT. 20.) .AND. (ATRIB(19) .LE. 30.)) THEN

        J = ATRIB(19) - 20
```

```
C***     CALCULATE THE PORTION OF THE CHANNEL THE DISK IS USING
         IF ((J .GE. 1) .AND. (J .LE. XX(22))) THEN
            ITEMP = NINT(1 / DISK(J,6))
            USERF = ITEMP
         ELSE
           PRINT *,'ERROR : ILLEGAL DISK'
           PRINT *,(ATRIB(K),K=1,20)
         END IF
         RETURN
       END IF


C***   IF IS THE CARD READER USING THE CHANNEL
       IF (ATRIB(19) .EQ. SPLR) THEN

C***     CALCULATE THE PORTION OF THE CHANNEL THE DISK IS USING
            ITEMP = NINT(1 / ((XX(20)/XX(18)) * 60))
            USERF = ITEMP
         RETURN
       END IF

C***   IF IS THE LINE PRINTER USING THE CHANNEL
       IF (ATRIB(19) .EQ. OSPLR) THEN

C***     CALCULATE THE PORTION OF THE CHANNEL THE DISK IS USING
            ITEMP = NINT(1 / ((XX(27)/XX(25)) * 60))
            USERF = ITEMP
         RETURN
       END IF

C***   IF IT IS NONE OF THE ABOVE THEN THERE IS AN ERROR
       PRINT *,'ERROR: TRYING TO ACCESS CHANNEL WITH ILLEGAL DEVICE'
       PRINT *,(ATRIB(K),K=1,20)
       RETURN

       END
```

AD-A138 116 CPESIM II: A COMPUTER SYSTEM SIMULATION FOR COMPUTER PERFORMANCE EVALUATION USE(U) AIR FORCE INST OF TECH WRIGHT-PATTERSON AFB OH SCHOOL OF ENGI.. D L OWEN 3/4

UNCLASSIFIED DEC 83 AFIT/GCS/EE/83D-16 F/G 9/2 NL



MICROCOPY RESOLUTION TEST CHART
NATIONAL BUREAU OF STANDARDS-1963-A

```
;*************************************************************
;                                                           *
;       DATE:  5 DEC 1983                                   *
;       VERSION:  1.0                                       *
;                                                           *
;       NAME:  SIMS                                         *
;       FUNCTION: PERFORMS NETWORK PORTION OF CPESIM II     *
;       FILES READ: NONE.                                   *
;       FILES WRITTEN:  NONE.                               *
;       NETWORKS:  MAIN JOB FLOW, OUTPUT SPOOLER, DISK,     *
;                  AND CHANNEL NETWORKS                     *
;                                                           *
;       AUTHOR:  DAVID L. OWEN                              *
;       HISTORY: N/A.                                       *
;                                                           *
;*************************************************************

GEN,DAVID L. OWEN,ABC COMPUTER SIMULATION,12/05/83;
LIMITS,40,24,300;
PRIORITY/3,HVF(11)/2,LVF(5);
NETWORK;
      RESOURCE/INQ(1),1;      INPUT QUEUE
      RESOURCE/HOLDQ(1),2;    HOLD QUEUE
      RESOURCE/EXECQ(1),3;    EXECUTE QUEUE
      RESOURCE/OUTQ(1),4;     OUTPUT QUEUE
      RESOURCE/DUM1(1),5;     DUMMY 1 QUEUE
      RESOURCE/DUM2(1),6;     DUMMY 2 QUEUE
      RESOURCE/DUM3(1),7;     DUMMY 3 QUEUE
      RESOURCE/DUM4(1),8;     DUMMY 4 QUEUE
      RESOURCE/DUM5(1),9;     DUMMY 5 QUEUE
      RESOURCE/DUM6(1),10;    DUMMY 6 QUEUE
      RESOURCE/TPQ1(1),11;    TAPE 1 QUEUE
      RESOURCE/TPQ2(1),12;    TAPE 2 QUEUE
      RESOURCE/TPQ3(1),13;    TAPE 3 QUEUE
      RESOURCE/TPQ4(1),14;    TAPE 4 QUEUE
      RESOURCE/TPQ5(1),15;    TAPE 5 QUEUE
      RESOURCE/TPQ6(1),16;    TAPE 6 QUEUE
      RESOURCE/TPQ7(1),17;    TAPE 7 QUEUE
      RESOURCE/TPQ8(1),18;    TAPE 8 QUEUE
      RESOURCE/TPQ9(1),19;    TAPE 9 QUEUE
      RESOURCE/TPQ10(1),20;   TAPE 10 QUEUE
      RESOURCE/DSQ1(1),21;    DISK 1 QUEUE
      RESOURCE/DSQ2(1),22;    DISK 2 QUEUE
      RESOURCE/DSQ3(1),23;    DISK 3 QUEUE
      RESOURCE/DSQ4(1),24;    DISK 4 QUEUE
      RESOURCE/DSQ5(1),25;    DISK 5 QUEUE
      RESOURCE/DSQ6(1),26;    DISK 6 QUEUE
      RESOURCE/DSQ7(1),27;    DISK 7 QUEUE
      RESOURCE/DSQ8(1),28;    DISK 8 QUEUE
      RESOURCE/DSQ9(1),29;    DISK 9 QUEUE
      RESOURCE/DSQ10(1),30;   DISK 10 QUEUE
      RESOURCE/CNLQ1(0),31;    CHANNEL 1 QUEUE
      RESOURCE/CNLQ2(0),32;    CHANNEL 2 QUEUE
```

```
         RESOURCE/CNLQ3(0),33;   CHANNEL 3 QUEUE
         RESOURCE/CNLQ4(0),34;   CHANNEL 4 QUEUE
         RESOURCE/CNLQ5(0),35;   CHANNEL 5 QUEUE
;
;
;===============================================
;
;       ATTRIBUTES
;
;   ATRIB(1)     ARRIVAL TIME
;   ATRIB(2)     JOB NAME
;   ATRIB(3)     CPU TIME REQUIRED
;   ATRIB(4)     MEMORY
;   ATRIB(5)     PRIORITY
;   ATRIB(6)     ALLOCATABLE DEVICES NEEDED
;   ATRIB(7)     CARDS
;   ATRIB(8)     LINES
;   ATRIB(9)     DISK BLOCKS
;   ATRIB(10)    ALLOCATABLE DEVICE BLOCKS
;   ATRIB(11)    JOB-TYPE    1. USER JOB
;                            2. INPUT SPOOLER
;                            3. OUTPUT SPOOLER
;                            4. S/W MONITOR
;                            5. JOB SCHEDULER
;   ATRIB(12)    CPU TIME USED
;   ATRIB(13)    I/O TIME USED
;   ATRIB(14)    MEMEORY SIZE USED
;   ATRIB(15)    DEPARTURE TIME
;   ATRIB(16)    TIME OF LAST I/O
;   ATRIB(17)    TIME OF LAST TAPE I/O
;   ATRIB(18)    CPU TIME LEFT
;   ATRIB(19)    ASSIGNED DISK
;   ATRIB(20)    ASSIGNED CHANNEL
;   ATRIB(21)    QUEUE NAME (USED WITH S/W MONITOR)
;   ATRIB(22)    TIME  (TIME JOB ENTERED QUEUE)
;   ATRIB(23)    INPUT-FROM (WHERE JOB CAME FROM PRIOR TO QUEUE)
;   ATRIB(24)    OUTPUT-TO (WHERE JOB WILL GO AFTER QUEUE)
;
;=============================================
;
;
;==========================================
;
;        XX VARIABLES
;
;   XX(1) = SPOOLERON (INPUT SPOOLER IN SYSTEM)
;   XX(2) = SWMON FLAG
;   XX(3) = NUMBER OF MEMORY PARTITIONS
;   XX(4) = CPU START TIME
;   XX(5) = CPU RATIO FOR S/W MON (1.0 = S/W MON OFF, .95 = S/W MON ON)
;   XX(6) = RELATIVE CPU SPEED
;   XX(7) = TIME SLICE
;   XX(8) = START I/O
;   XX(9) = NUMBER OF TAPE DRIVES
;   XX(10) = NUMBER OF AVAILABLE TAPE DRIVES
;   XX(11) = JOB SCHEDULER IN EXECQ (0 = TRUE, 1 = FALSE)
;   XX(12) = OSPOOLERON (OUTPUT SOOLER IN SYSTEM)
;   XX(13) = CPU TIME REQUIRED FOR JOB SCHEDULER TO EXECUTE
;   XX(14) = CPU TIME FOR INPUT SPOOLER TO EXECUTE
;   XX(15) = INPUT SPOOLER STATUS (0 -START OF JOB,
;              1 - WRITE BUFFER TO DISK, 2 - READ CARDS INTO BUFFER)
;   XX(16) = OUTPUT SPOOLER STATUS (0 -START OF JOB,
;              1 - PRINT BUFFER, 2 - LOAD BUFFER FROM DISK)
;   XX(17) = BLOCK SIZE (BYTES)
;   XX(18) = CARD READER SPEED (CARDS PER MINUTE)
;   XX(19) = CARD RECORD SIZE (BYTES)
;   XX(20) = CARD PER BUFFER (CALCULATED FROM XX(17) AND XX(19) )
;   XX(21) = NEXT DISK
;   XX(22) = NUMBER OF DISK DRIVES
;   XX(23) = NUMBER OF CHANNELS
;   XX(24) = NEXT TAPE
;   XX(25) = PRINTER SPEED (LINES PER MINUTE)
;   XX(26) = LINE RECORD SIZE (BYTES)
;   XX(27) = LINES PER BUFFER (CALCULATED FROM XX(17) AND XX(26)
;
;   XX(30) = H/W MONITOR (0 = OFF, 1 = ON)
;   XX(31) = CPU COUNT FOR H/W MON
;   XX(32) = CPU TIMER FOR H/W MON
;   XX(33) = H/W MONITOR START TIME
;   XX(34) = H/W MONITOR STOP TIME
;   XX(35) = HOW OFTEN H/W MONITOR RECORDS DATA
;   XX(36) = CPU START TIME FOR H/W MON
;   XX(37) = CPU FINISH TIME FOR H/W MON
;
;   XX(40) = TOTAL CPU TIME USED BY THE INPUT SPOOLER
;   XX(41) = TOTAL CPU TIME USED BY THE OUTPUT SPOOLER
;   XX(42) = TOTAL CPU TIME USED BY THE JOB SCHEDULER
;   XX(43) = S/W MONITOR START TIME
;   XX(44) = S/W MONITOR STOP TIME
;
;=========================================
;
;
;=====================================================
;     BEGIN NETWORK
;=====================================================
;
;
      ENTER,1;                 JOB ARRIVAL, ASSIGN ATTRIBUTES
      GOON,2;
      ACT/1,0.,,GON2;               PUT JOB IN INPUT QUEUE
      ACT/2,0,XX(1).NE.1,SPO;       SPOOLER IDLE, PUT IN HOLD QUEUE
 SPO  ASSIGN,XX(1)=1;              FLAG INDICATING SPOOLER LOADED
      ACT;
      EVENT,2;                     LOAD SPOOLER IN HOLD QUEUE
      TERM;
```

```
;
 GON2 GOON,1;
      ACT/3,0,XX(2).NE.1,QINP;     LOAD JOB IMEDIATELY INTO INPUT QUEUE
      ACT/4,0,XX(2).EQ.1;          STORE DATA FOR S/W MONITOR
      ASSIGN,ATRIB(21)=1.0;
      ASSIGN,ATRIB(22)=TNOW;
      ASSIGN,ATRIB(23)=0.0;
      ASSIGN,ATRIB(24)=2.0;
      ACT;
;
 QINP AWAIT(1),INQ/1,1;           WAIT IN INPUT QUEUE
;
;                                  TRANSFER JOB TO HOLD QUEUE
      ACT/5,0,XX(2).NE.1,JT;
      ACT/6,0,XX(2).EQ.1;
      EVENT,23;                    RECORD DATA ON S/W MON FILE
 JT   ASSIGN,ATRIB(11)=1;          SET JOB TYPE TO USER JOB
      ASSIGN,ATRIB(23)=1.0;        SET 'INPUT FROM' TO INPUT QUEUE
      ACT/7,0,,GON3;
      ENTER,2;                     INPUT SPOOLER
      ASSIGN,ATRIB(23)=5.0;        SET 'INPUT FROM' TO INPUT SPOOLER
      ACT/8,0.0,,GON3;
      ENTER,7;                     OUTPUT SPOOLER
      ASSIGN,ATRIB(23)=6.0;        SET 'INPUT FROM' TO OUTPUT SPOOLER
      ACT/9,0,,GON3;
      ENTER,21;                    S/W MONITOR
      ASSIGN,ATRIB(23)=7.0;        SET 'INPUT FROM' TO S/W MONITOR
 GON3 GOON,1;
;
      ACT/10,0,XX(2).NE.1,GON4;      IF S/W MON NOT ON, GO TO GON4
      ACT/11,0,XX(2).EQ.1;            IF S/W MON ON, STORE DATA FIRST
      ASSIGN,ATRIB(21)=2.0;
      ASSIGN,ATRIB(22)=TNOW;
      ASSIGN,ATRIB(24)=3.0;
      ACT;
;
 GON4 GOON;
      ACT/22,0.,,QHLD;
      ACT/23,0.,XX(11).NE.1,ET5;       IF JSCHED NOT LOADED IN EXECQ
ET5   EVENT,5;                            THEN LOAD JOB SCHED
      TERM;
;
 QHLD AWAIT(2),HOLDQ/1,1;       WAIT IN HOLD QUEUE
;
      TERM;
;
;
      QUEUE(5);                 DUMMY QUEUE SO THAT CAN RECORD
      ACT/78,0.0;               S/W MONITOR DATA BEFORE GOING TO
      GOON,1;                   EXECUTE QUEUE
;
      ASSIGN,ATRIB(23)=2.0;        SET 'INPUT FROM' TO HOLD QUEUE
;                                IF S/W MON NOT ON THEN GO STAIGHT
```

```
     ACT/12,0,XX(2).NE.1,GON5;     TO THE GOON NODE
;
     ACT/13,0,XX(2).EQ.1;     IF S/W MON ON THEN
     EVENT,23;                 WRITE DATA TO DISK AND GO TO GOON NODE
     ACT/14,0,,GON5;
     ENTER,4;                  RETURN OF JOB AFTER TIMEOUT
     ASSIGN,ATRIB(23)=3.0;         SET 'INPUT FROM' TO EXEC QUEUE
     ACT/15,0,,GON5;
     ENTER,3;                  RETURN OF JOB AFTER DISK I/O
     ASSIGN,ATRIB(23)=ATRIB(20)+30; SET 'INPUT FROM' TO THE CHANNEL
     ACT/16,0,,GON5;
     ENTER,18;                 INSERTION OF JOB SCHEDULER
     ASSIGN,ATRIB(23)=8.0;         SET 'INPUT FROM' TO JOB SCHEDULER
     ACT/17,0,,GON5;
     ENTER,5;                  RETURN OF JOB AFTER TAPE I/O
     ASSIGN,ATRIB(23)=ATRIB(20)+30;  SET 'INPUT FROM' TO INPUT QUEUE
 GON5 GOON,1;
;
     ACT/18,0,XX(2).NE.1,QEXC;  IF S/W MON NOT ON THEN PUT
;                              JOB INTO QEXEC
     ACT/19,0,XX(2).EQ.1;         IF S/W MON ON THEN
     ASSIGN,ATRIB(21)=3.0;
     ASSIGN,ATRIB(22)=TNOW;
     ASSIGN,ATRIB(24)=36.0;
     ACT;
 QEXC AWAIT(3),EXECQ/1,1;         WAIT IN EXECUTE QUEUE FOR CPU
     ACT/20,0,XX(2).NE.1,ET4;      IF S/W MON NOT ON THEN GO TO ET4
     ACT/21,0,XX(2).EQ.1;          IF S/W MON ON THEN
     EVENT,23;                     WRITE S/W MON DATA TO DISK BEFORE
     ACT;                          GOING TO ET4
;
ET4  EVENT,4;                      PERFORM CPU BURST
     TERM;
;
;*********************************************
;***                                       ***
;***      OUTPUT SPOOLER NETWORK           ***
;***                                       ***
;*********************************************
;
     ENTER,10;            ENTER USER JOB AFTER COMPLETION
     ACT/24;
;
 GON6 GOON;
     ACT/25,0,,GON7;               PUT JOB INTO OUTPUT QUEUE
     ACT/26,0,XX(12).NE.1;         OUTPUT SPOLER NOT IN SYSTEM SO
     EVENT,6;                  LOAD SPOOLER
     TERM;
;
 GON7 GOON,1;
     ACT/27,0.,XX(2).NE.1,QOUT;   S/W MON NOT ON
     ACT/28,0.,XX(2).EQ.1;        S/W MON ON SO RECORD DATA IN ATRIB
     ASSIGN,ATRIB(21)=4.0;
```

```
         ASSIGN,ATRIB(22)=TNOW;
         ASSIGN,ATRIB(23)=36.0;
         ASSIGN,ATRIB(24)=9.0;
         ACT/29;
;
 QOUT AWAIT(4),OUTQ/1;
         ACT,0,XX(2).NE.1,ET19;      IF S/W MON NOT ON THEN GO TO ET19
         ACT,0,XX(2).EQ.1;          IF S/W MON ON THEN
         EVENT,23;                     WRITE S/W MON DATA TO DISK BEFORE
         ACT/30;                       GOING TO ET19
;
 ET19 EVENT,19;
;
         TERM;
;*******************************************
;***
;***     DISK NETWORKS
;***
;*******************************************
;
         ENTER,23,1;
         ACT/80,0.,XX(2).NE.1,GON8;      IF S/W MON NOT ON GO TO GON8
         ACT/81,0.,XX(2).EQ.1;        IF S/W MON ON THEN RECORD ATRIBUTES
         ASSIGN,ATRIB(21)=ATRIB(19);  DISK WAITING FOR
         ASSIGN,ATRIB(22)=TNOW;
         ASSIGN,ATRIB(23)=36.0;       CPU
         ASSIGN,ATRIB(24)=37.0;       GENERAL CHANNEL
;                                     DECIDE WHICH DISK TO GO TO
 GON8 GOON,1;
         ACT(1)/31,0.0,ATRIB(19).EQ.21,DK1;
         ACT(1)/32,0.0,ATRIB(19).EQ.22,DK2;
         ACT(1)/33,0.0,ATRIB(19).EQ.23,DK3;
         ACT(1)/34,0.0,ATRIB(19).EQ.24,DK4;
         ACT(1)/35,0.0,ATRIB(19).EQ.25,DK5;
         ACT(1)/36,0.0,ATRIB(19).EQ.26,DK6;
         ACT(1)/37,0.0,ATRIB(19).EQ.27,DK7;
         ACT(1)/38,0.0,ATRIB(19).EQ.28,DK8;
         ACT(1)/39,0.0,ATRIB(19).EQ.29,DK9;
         ACT(1)/40,0.0,ATRIB(19).EQ.30,DK10;
         ACT(1)/41,0.0,,ERR1;
;
 DK1  AWAIT(21),DSQ1/1;
         ACT,0,XX(2).NE.1,D1;      IF S/W MON NOT ON THEN GO TO D1
         ACT,0,XX(2).EQ.1;          IF S/W MON ON THEN
         EVENT,23;                     WRITE S/W MON DATA TO DISK BEFORE
         ACT/42;                       GOING TO D1
 D1      EVENT,15;
         ACT/43;
         TERM;
;
 DK2  AWAIT(22),DSQ2/1;
         ACT,0,XX(2).NE.1,D2;      IF S/W MON NOT ON THEN GO TO D2
         ACT,0,XX(2).EQ.1;          IF S/W MON ON THEN
```

```
        EVENT,23;                  WRITE S/W MON DATA TO DISK BEFORE
        ACT/44;                    GOING TO D2
   D2   EVENT,15;
        ACT/45;
        TERM;
;
   DK3  AWAIT(23),DSQ3/1;
        ACT,0,XX(2).NE.1,D3;     IF S/W MON NOT ON THEN GO TO D3
        ACT,0,XX(2).EQ.1;         IF S/W MON ON THEN
        EVENT,23;                    WRITE S/W MON DATA TO DISK
        ACT/46;
   D3   EVENT,15;
        ACT/47;
        TERM;
;
   DK4  AWAIT(24),DSQ4/1;
        ACT,0,XX(2).NE.1,D4;     IF S/W MON NOT ON THEN GO TO D4
        ACT,0,XX(2).EQ.1;         IF S/W MON ON THEN
        EVENT,23;                    WRITE S/W MON DATA TO DISK
        ACT/48;
   D4   EVENT,15;
        ACT/49;
        TERM;
;
   DK5  AWAIT(25),DSQ5/1;
        ACT,0,XX(2).NE.1,D5;     IF S/W MON NOT ON THEN GO TO D5
        ACT,0,XX(2).EQ.1;         IF S/W MON ON THEN
        EVENT,23;                    WRITE S/W MON DATA TO DISK
        ACT/49;
   D5   EVENT,15;
        ACT/50;
        TERM;
;
   DK6  AWAIT(26),DSQ6/1;
        ACT,0,XX(2).NE.1,D6;     IF S/W MON NOT ON THEN GO TO D6
        ACT,0,XX(2).EQ.1;         IF S/W MON ON THEN
        EVENT,23;                    WRITE S/W MON DATA TO DISK
        ACT/51;
   D6   EVENT,15;
        ACT/52;
        TERM;
;
   DK7  AWAIT(27),DSQ7/1;
        ACT,0,XX(2).NE.1,D7;     IF S/W MON NOT ON THEN GO TO D7
        ACT,0,XX(2).EQ.1;         IF S/W MON ON THEN
        EVENT,23;                    WRITE S/W MON DATA TO DISK
        ACT/53;
   D7   EVENT,15;
        ACT/54;
        TERM;
;
   DK8  AWAIT(28),DSQ8/1;
        ACT,0,XX(2).NE.1,D8;     IF S/W MON NOT ON THEN GO TO D8
        ACT,0,XX(2).EQ.1;           IF S/W MON ON THEN
        EVENT,23;                      WRITE S/W MON DATA TO DISK
        ACT/55;
   D8   EVENT,15;
        ACT/56;
        TERM;
;
 DK9    AWAIT(29),DSQ9/1;
        ACT,0,XX(2).NE.1,D9;       IF S/W MON NOT ON THEN GO TO D9
        ACT,0,XX(2).EQ.1;           IF S/W MON ON THEN
        EVENT,23;                      WRITE S/W MON DATA TO DISK
        ACT/57;
 D9     EVENT,15;
        ACT/58;
        TERM;
;
 DK10 AWAIT(30),DSQ10/1;
        ACT,0,XX(2).NE.1,D10;       IF S/W MON NOT ON THEN GO TO D10
        ACT,0,XX(2).EQ.1;           IF S/W MON ON THEN
        EVENT,23;                      WRITE S/W MON DATA TO DISK
        ACT/60;
 D10    EVENT,15;
        ACT/61;
        TERM;
;
 ERR1 TERM;                ERROR ROUTINE TO GO HERE
;
;********************************************
;***
;***    CHANNEL NETWORKS
;***
;********************************************
;
        ENTER,25,1;
        ACT/82,0.,XX(2).NE.1,GON9;   IF S/W MON NOT ON GO TO GON9
        ACT/83,0.,XX(2).EQ.1;      IF S/W MON ON THEN LOAD ATRIBUTES
        ASSIGN,ATRIB(21)=ATRIB(20)+30;  CHANEL WAITING FOR
        ASSIGN,ATRIB(22)=TNOW;
        ASSIGN,ATRIB(23)=ATRIB(19);  I/O DEVICE
        ASSIGN,ATRIB(24)=3.0;       EXEC  QUEUE
;                          DECIDE WHICH CHANNEL TO GO TO
 GON9 GOON,1;
        ACT(1)/62,0.0,ATRIB(20).EQ.1,CH1;
        ACT(1)/63,0.0,ATRIB(20).EQ.2,CH2;
        ACT(1)/64,0.0,ATRIB(20).EQ.3,CH3;
        ACT(1)/65,0.0,ATRIB(20).EQ.4,CH4;
        ACT(1)/66,0.0,ATRIB(20).EQ.5,CH5;
        ACT(1)/67,0.0,,ERR2;
;
 CH1    AWAIT(31),CNLQ1/USERF(1);
        ACT,0,XX(2).NE.1,C1;       IF S/W MON NOT ON THEN GO TO C1
        ACT,0,XX(2).EQ.1;           IF S/W MON ON THEN
        EVENT,23;                      WRITE S/W MON DATA TO DISK
        ACT/68;
 C1     EVENT,16;
        ACT/69;
        TERM;
;
 CH2    AWAIT(32),CNLQ2/USERF(1);
        ACT,0,XX(2).NE.1,C2;      IF S/W MON NOT ON THEN GO TO C2
        ACT,0,XX(2).EQ.1;          IF S/W MON ON THEN
        EVENT,23;                     WRITE S/W MON DATA TO DISK
        ACT/70;
 C2     EVENT,16;
        ACT/71;
        TERM;
;
 CH3    AWAIT(33),CNLQ3/USERF(1);
        ACT,0,XX(2).NE.1,C3;      IF S/W MON NOT ON THEN GO TO C3
        ACT,0,XX(2).EQ.1;          IF S/W MON ON THEN
        EVENT,23;                     WRITE S/W MON DATA TO DISK
        ACT/72;
 C3     EVENT,16;
        ACT/73;
        TERM;
;
 CH4    AWAIT(34),CNLQ4/USERF(1);
        ACT,0,XX(2).NE.1,C4;      IF S/W MON NOT ON THEN GO TO C4
        ACT,0,XX(2).EQ.1;          IF S/W MON ON THEN
        EVENT,23;                     WRITE S/W MON DATA TO DISK
        ACT/74;
 C4     EVENT,16;
        ACT/75;
        TERM;
;
CH5     AWAIT(35),CNLQ5/USERF(1);
        ACT,0,XX(2).NE.1,C5;      IF S/W MON NOT ON THEN GO TO C5
        ACT,0,XX(2).EQ.1;          IF S/W MON ON THEN
        EVENT,23;                     WRITE S/W MON DATA TO DISK
        ACT/76;
 C5     EVENT,16;
        ACT/77;
        TERM;
;
 ERR2 TERM;                 ERROR ROUTINE TO GO HERE
;
        END;
INIT,0,600000;
MONTR,CLERA,20.,20.0;
FIN;
```

```
C                                                          *
C       DATE:  5 DEC 1983                                  *
C       VERSION:  1.0                                      *
C                                                          *
C       NAME:  SETUP                                       *
C       FUNCTION:  READS IN AVAILABLE HARDWARE EQUIPMENT   *
C               LIST, QUERIES USER ON CONFIGURATION        *
C               DESIRED AND THEN WRITES CONFIG FILE        *
C       FILES READ: TYPES                                  *
C       FILES WRITTEN:  CONFIG                             *
C       SUBROUTINES CALLED:  NONE.                         *
C       CALLING SUBROUTINES:  NONE.                        *
C                                                          *
C       AUTHOR:  DAVID L. OWEN                             *
C       HISTORY: N/A.                                      *
C                                                          *
C***********************************************************

      PROGRAM MAIN(TYPES,CONFIG)

      DIMENSION DSPEED(10),DCOST(10),TSPEED(10),TCOST(10),
     1   CSPEED(5),CCOST(5),RSPEED(5),RCOST(5),PCOST(5),PSPEED(5),
     1   USPEED(5),UCOST(5),PART(20),ICHANL(5),IDISK(10,6),
     1   ITAPE(10,6),IREAD(6),IPRINT(6),ISWMQ(5),IHWCNT(5)
      CHARACTER DNAME(10)*20, TNAME(10)*20, CNAME(5)*20,
     1   RNAME(5)*20,PNAME(5)*20,UNAME(5)*20,SANSWR*1,HANSWR*1

      REAL HSEC

      PRINT *,'OPENING FILES'


C***  OPEN INPUT FILE WHICH CONTAINS THE TYPES OF DEVICES
      OPEN(UNIT=15,FILE='TYPES',STATUS='OLD',ERR=990,IOSTAT=IOS,
     1     ACCESS='SEQUENTIAL',FORM='FORMATTED')

C***  OPEN CONFIG FILE WHICH WILL CONTAIN THE COMPUTER CONFIGURATION
      OPEN(UNIT=11,FILE='CONFIG',STATUS='NEW',ERR=990,
     1 IOSTAT=IOS,ACCESS='SEQUENTIAL',FORM='FORMATTED')

      PRINT *,'FILES OPENED'

C***  READ NUMBER OF DIFFERENT TYPES OF DISKS
      READ(UNIT=15,FMT=100,ERR=999)NUMD

C***  READ DISK TYPES IN
      DO 1 I=1,NUMD
        READ (UNIT=15,FMT=101,ERR=999)DNAME(I),DSPEED(I),DCOST(I)
1     CONTINUE

C***  READ NUMBER OF DIFFERENT TYPES OF TAPE DRIVES
      READ(UNIT=15,FMT=100,ERR=999)NUMT
C***  READ TAPE TYPES
```

```
      DO 2 I=1,NUMT
         READ (UNIT=15,FMT=101,IOSTAT=IOS,ERR=999)
     1         TNAME(I),TSPEED(I),TCOST(I)
2     CONTINUE

C***  READ NUMBER OF DIFFERENT TYPES OF CHANNELS
      READ (UNIT=15,FMT=100,ERR=999,IOSTAT=IOS)NUMC
C***  READ CHANNEL TYPES
      DO 3 I=1,NUMC
      READ (UNIT=15,FMT=101,ERR=999,IOSTAT=IOS)CNAME(I),
     1              CSPEED(I),CCOST(I)
3     CONTINUE

C***  READ NUMBER OF DIFFERENT TYPES OF CARD READERS
      READ (UNIT=15,FMT=100,ERR=999,IOSTAT=IOS)NUMR
C***  READ CARD READER TYPES
      DO 4 I=1,NUMR
      READ (UNIT=15,FMT=101,ERR=999,IOSTAT=IOS)RNAME(I),
     1             RSPEED(I),RCOST(I)
4     CONTINUE

C***  READ NUMBER OF DIFFERENT TYPES OF LINE PRINTERS
      READ (UNIT=15,FMT=100,ERR=999,IOSTAT=IOS)NUMP
C***  READ PRINTER TYPES
      DO 5 I=1,NUMP
      READ (UNIT=15,FMT=101,ERR=999,IOSTAT=IOS)PNAME(I),
     1           PSPEED(I),PCOST(I)
5     CONTINUE

C***  READ NUMBER OF DIFFERENT TYPES OF CPUS
      READ (UNIT=15,FMT=100,ERR=999,IOSTAT=IOS)NUMU
C***  READ CPUS TYPES
      DO 6 I=1,NUMU
      READ (UNIT=15,FMT=101,ERR=999,IOSTAT=IOS)UNAME(I),
     1            USPEED(I),UCOST(I)
6     CONTINUE

      PRINT *,' '
      PRINT *,' '

C******************************************************
C***  CPU S                                         ***
C******************************************************

C***  QUERY USER ON TYPE OF CPUS
7     PRINT *,'WHICH TYPE OF CPU WOULD YOU LIKE'
      DO 8 I=1,NUMU
      PRINT *,I,'.  ',UNAME(I),' SPEED = ',USPEED(I),
     1   ' COST = $',UCOST(I)
8     CONTINUE
      PRINT *,' '
      PRINT *,'ENTER TYPE (1,2,..) :'
      READ *,ICPU
      IF ((ICPU .LT. 1) .OR. (ICPU .GT. NUMU)) THEN
         PRINT *,'ILLEGAL CPU TYPE'
         GOTO 7
      END IF
      PRINT *,' '

C***  QUERY USER ON NUMBER OF CPUS
55    PRINT *,'ENTER NUMBER OF CPUS DESIRED (MAX 99): '
      READ *,NCPUS
      IF ((NCPUS .GT. 99) .OR. (NCPUS .LT. 1)) THEN
         PRINT *,'ILLEGAL NUMBER OF CPUS'
         GO TO 55
      END IF

      PRINT *,' '
C***  QUERY USER ON TIME SLICE
56    PRINT *,' ENTER TIME SLICE (IN SECONDS): '
      READ *,TSLICE
      IF ((TSLICE .LT .0001) .OR. (TSLICE .GT. 99999.)) THEN
        PRINT *,'TIME SLICE RANGE .0001 TO 99999. SECONDS'
        GOTO 56
      END IF

      PRINT *,' '
      PRINT *,' '

C*****************************************
C***   MEMORY PARTITIONS                ***
C******************************************

C***  QUERY USER ON NUMBER OF MEMORY PARTITIONS
9     PRINT *,'ENTER NUMBER OF MEMORY PARTITIONS DESIRED (MAX 20) '
      READ *,NPARTS
      IF ((NPARTS .GT. 20) .OR. (NPARTS .LE. 0)) THEN
         PRINT *,'ILLEGAL NUMBER OF MEMORY PARTITIONS'
         GOTO 9
      END IF
      PRINT *,' '

C***  QUERY USER ON SIZE OF MEMORY PARTITIONS
      PRINT *,'ENTER PARTITION SIZES IN K'
      DO 10 I=1,NPARTS
         PRINT *,'PARTITION(',I,')  SIZE (IN K) : '
         READ *,PART(I)
         PRINT *,' '
10    CONTINUE

      PRINT *,' '
      PRINT *,' '

C******************************************************
C***  CHANNELS                                      ***
C******************************************************
```

```
C***  QUERY USER ON NUMBER OF CHANNELS
14    PRINT *,'ENTER NUMBER OF CHANNELS DESIRED (MAX 5) :'
      READ *,NCHAN

      IF ((NCHAN .LE. 0) .OR. (NCHAN .GT. 5)) THEN
         PRINT *,'ILLEGAL NUMBER OF CHANNELS'
         GO TO 14
      END IF

      DO 13 K=1,NCHAN
         PRINT *,' '
C***     QUERY USER ON TYPE OF CHANNELS
11    PRINT *,'WHICH TYPE WOULD YOU LIKE FOR CHANNEL(',K,'): '
         DO 12 I=1,NUMC
           PRINT *,I,'.  ',CNAME(I),' DATA RATE =  ',
     1       CSPEED(I),' COST =$',CCOST(I)
12       CONTINUE
         PRINT *,'ENTER TYPE (1,2,..)'
         READ *,ICHAN
         IF ((ICHAN .LT. 1) .OR. (ICHAN .GT. NUMC)) THEN
            PRINT *,'ILLEGAL CHANNEL TYPE'
            GOTO 11
         END IF
         ICHANL(K) = ICHAN

13    CONTINUE

      PRINT *,' '
      PRINT *,' '

C*****************************************************
C***  DISKS                                        ***
C*****************************************************

C***  QUERY USER ON NUMBER OF DISKS
15    PRINT *,'ENTER NUMBER OF DISKS/DRUMS DESIRED (MAX 10) :'
      READ *,NDISK

      IF ((NDISK .LE. 0) .OR. (NDISK .GT. 10)) THEN
         PRINT *,'ILLEGAL NUMBER OF DISKS'
         GO TO 15
      END IF

      DO 20 K=1,NDISK
         PRINT *,' '
C***     QUERY USER ON TYPE OF DISKS
16       PRINT *,'WHICH TYPE OF DISK WOULD YOU LIKE'
         DO 17 I=1,NUMD
           PRINT *,I,'.  ',DNAME(I),' SPEED =  ',DSPEED(I),
     1       ' COST = $',DCOST(I)
17       CONTINUE
         PRINT *,' '
```

```
            PRINT *,'ENTER TYPE (1,2,..) FOR DISK ',K,': '
            READ *,IDSK
            IF ((IDSK .LT. 1) .OR. (IDSK .GT. NUMD)) THEN
               PRINT *,'ILLEGAL DISK TYPE'
               GOTO 16
            END IF
            IDISK(K,6) = IDSK

C***        GET CHANNEL CONNECTIONS
            PRINT *,'ENTER CHANNEL CONNECTIONS FOR DISK ',K
            PRINT *,'  0 - CHANNEL NOT CONNECTED TO DISK'
            PRINT *,'  1 - CHANNEL CONNECTED TO DISK'
            PRINT *,' '
            DO 19 J=1,5
             IF (J .LE. NCHAN) THEN
18             PRINT *,'CHANNEL ',J,' (0/1): '
               READ *,JJ
               IF ((JJ .EQ. 0) .OR. (JJ .EQ. 1)) THEN
                  IDISK(K,J) = JJ
                 ELSE
                  PRINT *,'ILLEGAL INPUT'
                  GOTO 18
               END IF
             ELSE
               IDISK(K,J) = 0
             END IF
19          CONTINUE

20    CONTINUE

      PRINT *,' '
      PRINT *,' '

C*******************************************************
C***  TAPES                                          ***
C*******************************************************

C***  QUERY USER ON NUMBER OF TAPES
21    PRINT *,'ENTER NUMBER OF TAPES DESIRED (MAX 10) :'
      READ *,NTAPE

      IF ((NTAPE .LE. 0) .OR. (NTAPE .GT. 10)) THEN
         PRINT *,'ILLEGAL NUMBER OF TAPES'
         GO TO 21
      END IF

      DO 26 K=1,NTAPE
         PRINT *,  '
C***     QUERY USER ON TYPE OF TAPES
22       PRINT *,'WHICH TYPE OF TAPE WOULD YOU LIKE'
         DO 23 I=1,NUMT
           PRINT *,I,'.  ',TNAME(I),' SPEED = ',TSPEED(I),
     1          ' COST = $',TCOST(I)
```

```
23        CONTINUE
          PRINT *,' '
          PRINT *,'ENTER TYPE (1,2,..) FOR TAPE ',K,': '
          READ *,ITAP
          IF ((ITAP .LT. 1) .OR. (ITAP .GT. NUMT)) THEN
             PRINT *,'ILLEGAL TAPE TYPE'
             GOTO 22
          END IF
          ITAPE(K,6) = ITAP

C***      GET CHANNEL CONNECTIONS
          PRINT *,'ENTER CHANNEL CONNECTIONS FOR TAPE ',K
          PRINT *,'  0 - CHANNEL NOT CONNECTED TO TAPE'
          PRINT *,'  1 - CHANNEL CONNECTED TO TAPE'
          PRINT *,' '
          DO 25 J=1,5
           IF (J .LE. NCHAN) THEN
24           PRINT *,'CHANNEL ',J,' (0/1): '
             READ *,JJ
             IF ((JJ .EQ. 0) .OR. (JJ .EQ. 1)) THEN
                ITAPE(K,J) = JJ
               ELSE
                PRINT *,'ILLEGAL INPUT'
                GOTO 24
             END IF
           ELSE
             ITAPE(K,J) = 0
           END IF
25        CONTINUE

26     CONTINUE

       PRINT *,' '
       PRINT *,' '

C******************************************************
C***   CARD READER                                 ***
C******************************************************

C***      QUERY USER ON TYPE OF CARD READER
27        PRINT *,'WHICH TYPE OF CARD READER WOULD YOU LIKE'
          DO 28 I=1,NUMR
            PRINT *,I,'.  ',RNAME(I),' SPEED = ',RSPEED(I),
     1        ' COST = $',RCOST(I)
28        CONTINUE
          PRINT *,' '
          PRINT *,'ENTER TYPE (1,2,..) OF CARD READER DESIRED '
          READ *,IRDR
          IF ((IRDR .LT. 1) .OR. (IRDR .GT. NUMR)) THEN
             PRINT *,'ILLEGAL CARD READER TYPE'
             GOTO 27
          END IF
          IREAD(6) = IRDR
```

```
C***     GET CHANNEL CONNECTIONS
         PRINT *,'ENTER CHANNEL CONNECTIONS FOR CARD READER'
         PRINT *,'  0 - CHANNEL NOT CONNECTED TO CARD READER'
         PRINT *,'  1 - CHANNEL CONNECTED TO CARD READER'
         PRINT *,' '
         DO 30 J=1,5
          IF (J .LE. NCHAN) THEN
29          PRINT *,'CHANNEL ',J,' (0/1): '
            READ *,JJ
            IF ((JJ .EQ. 0) .OR. (JJ .EQ. 1)) THEN
               IREAD(J) = JJ
              ELSE
               PRINT *,'ILLEGAL INPUT'
               GOTO 29
            END IF
          ELSE
            IREAD(J) = 0
          END IF
30       CONTINUE

      PRINT *,' '
      PRINT *,' '

C******************************************************
C***  LINE PRINTER                                  ***
C******************************************************

C***     QUERY USER ON TYPE OF LINE PRINTER
31       PRINT *,'WHICH TYPE OF LINE PRINTER WOULD YOU LIKE'
         DO 32 I=1,NUMP
           PRINT *,I,'.  ',PNAME(I),' SPEED =  ',PSPEED(I),
     1       '  COST = $',PCOST(I)
32       CONTINUE
         PRINT *,' '
         PRINT *,'ENTER TYPE (1,2,..) OF LINE PRINTER DESIRED '
         READ *,IPNTR
         IF ((IPNTR .LT. 1) .OR. (IPNTR .GT. NUMP)) THEN
            PRINT *,'ILLEGAL LINE PRINTER TYPE'
            GOTO 31
         END IF
         IPRINT(6) = IPNTR

C***     GET CHANNEL CONNECTIONS
         PRINT *,'ENTER CHANNEL CONNECTIONS FOR LINE PRINTER'
         PRINT *,'  0 - CHANNEL NOT CONNECTED TO LINE PRINTER'
         PRINT *,'  1 - CHANNEL CONNECTED TO LINE PRINTER'
         PRINT *,' '
         DO 34 J=1,5
          IF (J .LE. NCHAN) THEN
33          PRINT *,'CHANNEL ',J,' (0/1): '
            READ *,JJ
            IF ((JJ .EQ. 0) .OR. (JJ .EQ. 1)) THEN
```

```
               IPRINT(J) = JJ
              ELSE
               PRINT *,'ILLEGAL INPUT'
               GOTO 33
             END IF
           ELSE
             IPRINT(J) = 0
           END IF
34        CONTINUE

      PRINT *,' '
      PRINT *,' '

C*****************************************************
C***  SOFTWARE MONITOR                             ***
C*****************************************************

C***  QUERY USER IF HE WANTS TO USE SOFTWARE MONITOR
      PRINT *,'DO YOU WISH TO USE THE SOFTWARE MONITOR (Y/N)'
      READ *,SANSWR
      IF (SANSWR .EQ. 'Y') THEN
         PRINT *,'ENTER STARTING TIME OF S/W MONITOR'
         PRINT *,'DAY  HOUR MINUTE SECOND'
         READ *,ISDAY,ISHOUR,ISMIN,SSEC
         PRINT *,'ENTER STOPPING TIME'
         PRINT *,'DAY HOUR MINUTE SECOND'
         READ  *,JSDAY,JSHOUR,JSMIN,SSSEC
35       PRINT *,'YOU CAN MONITOR UP TO FIVE OF THE FOLLOWING QUEUES'
      PRINT *,' 1. INPUT     2. HOLD      3. EXEC      4. OUTPUT'
      PRINT *,'11. TAPE 1   12. TAPE 2   13. TAPE 3   14. TAPE 4'
      PRINT *,'15. TAPE 5   16. TAPE 6   17. TAPE 7   18. TAPE 8'
      PRINT *,'19. TAPE 9   20. TAPE 10  21. DISK 1   22. DISK 2'
      PRINT *,'23. DISK 3   24. DISK 4   25. DISK 5   26. DISK 6'
      PRINT *,'27. DISK 7   28. DISK 8   29. DISK 9   30. DISK 10'
      PRINT *,'31. CHAN 1   32. CHAN 2   33. CHAN 3   34. CHAN 4'
      PRINT *,'35. CHAN 5   36. NO QUEUE DESIRED'
         PRINT *,' '
         DO 36 I=1,5
            PRINT *,'ENTER QUEUE NUMBER : '
            READ *,IQ
            IF (((IQ .GE. 1) .AND. (IQ .LE. 4)) .OR.
     1         ((IQ .GE. 11) .AND. (IQ .LE. 36))) THEN
               ISWMQ(I) = IQ
             ELSE
               PRINT *,'ILLEGAL QUEUE'
               GOTO 35
            END IF
36       CONTINUE

      END IF

      PRINT *,' '
      PRINT *,' '
```

```
C******************************************************
C***  HARDWARE MONITOR                              ***
C******************************************************

C***  QUERY USER IF HE WANTS TO USE HARDWARE MONITOR
      PRINT *,'DO YOU WISH TO USE THE HARDWARE MONITOR (Y/N)'
      READ *,HANSWR
      IF (HANSWR .EQ. 'Y') THEN
         PRINT *,'ENTER STARTING TIME OF H/W MONITOR'
         PRINT *,'DAY  HOUR MINUTE SECOND'
         READ *,IHDAY,IHHOUR,IHMIN,HSEC
         PRINT *,'ENTER STOPPING TIME'
         PRINT *,'DAY HOUR MINUTE SECOND'
         READ  *,JHDAY.JHHOUR,JHMIN,SHSEC
75       PRINT *,'ENTER H/W MONITOR SAMPLE RATE (IN SECONDS) '
         READ *,RATEHW
         IF (RATEHW .GT. 99999) THEN
            PRINT *,'DATE RATE TO LARGE, MAX RATE IS 99999'
            GOTO 75
         END IF
37       PRINT *,'YOU CAN HAVE TWO TIMERS AND FIVE COUNTERS'
         PRINT *,'CONNECTED TO THE FOLLOWING DEVICES:'
      PRINT *,' 1. CPU       2. READER    3. PRINTER'
      PRINT *,'11. TAPE 1   12. TAPE 2   13. TAPE 3   14. TAPE 4'
      PRINT *,'15. TAPE 5   16. TAPE 6   17. TAPE 7   18. TAPE 8'
      PRINT *,'19. TAPE 9   20. TAPE 10  21. DISK 1   22. DISK 2'
      PRINT *,'23. DISK 3   24. DISK 4   25. DISK 5   26. DISK 6'
      PRINT *,'27. DISK 7   28. DISK 8   29. DISK 9   30. DISK 10'
      PRINT *,'31. CHAN 1   32. CHAN 2   33. CHAN 3   34. CHAN 4'
      PRINT *,'35. CHAN 5   36. NO DEVICE DESIRED'
         PRINT *,' '
         PRINT *,'ENTER NUMBER OF DEVICE FOR TIMER(1): '
         READ *,ICNT
         IF (((ICNT .GE. 1) .AND. (ICNT .LE. 3)) .OR.
     1        ((ICNT .GE. 11) .AND. (ICNT .LE. 36))) THEN
            IHTIM1 = ICNT
          ELSE
            PRINT *,'ILLEGAL DEVICE'
            GOTO 37
         END IF
         PRINT *,'ENTER NUMBER OF DEVICE FOR TIMER(2): '
         READ *,ICNT
         IF (((ICNT .GE. 1) .AND. (ICNT .LE. 3)) .OR.
     1        ((ICNT .GE. 11) .AND. (ICNT .LE. 36))) THEN
            IHTIM2 = ICNT
          ELSE
            PRINT *,'ILLEGAL DEVICE'
            GOTO 37
         END IF

         DO 38 I=1,3
```

```
            PRINT *,'ENTER DEVICE NUMBER OF COUNTER(',I,'): '
            READ *,ICNT
            IF (((ICNT .GE. 1) .AND. (ICNT .LE. 3)) .OR.
     1          ((ICNT .GE. 11) .AND. (ICNT .LE. 36))) THEN
              IHWCNT(I) = ICNT
             ELSE
              PRINT *,'ILLEGAL DEVICE'
              GOTO 37
            END IF
38       CONTINUE

      END IF

      PRINT *,' '
      PRINT *,' '

C*****************************************************
C***  WRITE DATA TO CONFIGUARATION FILE           ***
C*****************************************************


C***  NUMBER OF CPUS
      WRITE (UNIT=11,FMT=100,IOSTAT=IOS,ERR=999)NCPUS
C***  TYPE OF CPU
      WRITE (UNIT=11,FMT=101,IOSTAT=IOS,ERR=999)
     1       UNAME(ICPU),USPEED(ICPU),UCOST(ICPU)
C***  TIME SLICE
      WRITE (UNIT=11,FMT=112,IOSTAT=IOS,ERR=999)TSLICE
C***  WRITE NUMBER OF MEMORY PARTITIONS
      WRITE (UNIT=11,FMT=100,IOSTAT=IOS,ERR=999)NPARTS
C***  WRITE SIZE OF MEMORY PARTITIONS
      DO 40 I=1,NPARTS
         WRITE (UNIT=11,FMT=104,IOSTAT=IOS,ERR=999)I,PART(I)
40    CONTINUE
C***  WRITE NUMBER OF CHANNELS
      WRITE (UNIT=11,FMT=100,IOSTAT=IOS,ERR=999)NCHAN
C***  WRITE CHANNEL'S NAME, SPEED AND COST
      DO 41 I=1,NCHAN
         WRITE (UNIT=11,FMT=101,IOSTAT=IOS,ERR=999)
     1         CNAME(ICHANL(I)),CSPEED(ICHANL(I)),CCOST(ICHANL(I))
41    CONTINUE
C***  WRITE NUMBER OF DISKS
      WRITE (UNIT=11,FMT=100,IOSTAT=IOS,ERR=999)NDISK
C***  WRITE DISK'S NAME, SPEED, COST AND CHANNEL CONNECTIONS
      DO 42 I=1,NDISK
         WRITE (UNIT=11,FMT=105,IOSTAT=IOS,ERR=999)
     1     DNAME(IDISK(I,6)),DSPEED(IDISK(I,6)),DCOST(IDISK(I,6)),
     1     (IDISK(I,K),K=1,5)
42    CONTINUE
C***  WRITE NUMBER OF TAPES
      WRITE (UNIT=11,FMT=100,IOSTAT=IOS,ERR=999)NTAPE
C***  WRITE TAPE'S NAME, SPEED, COST AND CHANNEL CONNECTIONS
      DO 43 I=1,NTAPE
         WRITE (UNIT=11,FMT=105,IOSTAT=IOS,ERR=999)
     1     TNAME(ITAPE(I,6)),TSPEED(ITAPE(I,6)),TCOST(ITAPE(I,6)),
     1     (ITAPE(I,K),K=1,5)
43    CONTINUE
C***  WRITE CARD READER'S NAME, SPEED, COST AND CHANNEL CONNECTIONS
      WRITE (UNIT=11,FMT=105,IOSTAT=IOS,ERR=999)
     1     RNAME(IREAD(6)),RSPEED(IREAD(6)),RCOST(IREAD(6)),
     1     (IREAD(K),K=1,5)
C***  WRITE LINE PRINTER'S NAME, SPEED, COST AND CHANNEL CONNECTIONS
      WRITE (UNIT=11,FMT=105,IOSTAT=IOS,ERR=999)
     1     PNAME(IPRINT(6)),PSPEED(IPRINT(6)),PCOST(IPRINT(6)),
     1     (IPRINT(K),K=1,5)
C***  WRITE IF SOFTWARE MONITOR IS DESIRED
      WRITE (UNIT=11,FMT=106,IOSTAT=IOS,ERR=999)SANSWR
C***  WRITE START TIME, STOP TIME, AND QUEUES IF DESIRED
      IF (SANSWR .EQ. 'Y') THEN
         WRITE (UNIT=11,FMT=107,IOSTAT=IOS,ERR=999)
     1           ISDAY,ISHOUR,ISMIN,SSEC
         WRITE (UNIT=11,FMT=108,IOSTAT=IOS,ERR=999)
     1           JSDAY,JSHOUR,JSMIN,SSSEC
         WRITE (UNIT=11,FMT=109,IOSTAT=IOS,ERR=999)(ISWMQ(I),I=1,5)
      END IF
C***  WRITE IF HARDWARE MONITOR IS DESIRED
      WRITE (UNIT=11,FMT=106,IOSTAT=IOS,ERR=999)HANSWR
C***  WRITE START TIME, STOP TIME, TIMERS AND COUNTERS IF DESIRED
      IF (HANSWR .EQ. 'Y') THEN
         WRITE (UNIT=11,FMT=110,IOSTAT=IOS,ERR=999)
     1           IHDAY,IHHOUR,IHMIN,HSEC
         WRITE (UNIT=11,FMT=111,IOSTAT=IOS,ERR=999)
     1           JHDAY,JHHOUR,JHMIN,SHSEC
         WRITE (UNIT=11,FMT=102,IOSTAT=IOS,ERR=999)RATEHW
         WRITE (UNIT=11,FMT=109,IOSTAT=IOS,ERR=999)
     1           IHTIM1,IHTIM2,(IHWCNT(I),I=1,3)
      END IF

100   FORMAT(I2)
101   FORMAT(A20,1X,F10.4,1X,F8.2)
102   FORMAT('H/W MON SAMPLE RATE',T22,F10.4)
103   FORMAT(I5)
104   FORMAT('PARTITION ',I2,T22,F10.4)
105   FORMAT(A20,1X,F10.4,1X,F8.2,1X,5(1X,I1))
106   FORMAT(A1)
107   FORMAT('S/W MONITOR START',T22,3(I4,1X),F8.4)
108   FORMAT('S/W MONITOR STOP',T22,3(I4,1X),F8.4)
109   FORMAT(5(I2,1X))
110   FORMAT('H/W MONITOR START',T22,3(I4,1X),F8.4)
111   FORMAT('H/W MONITOR STOP',T22,3(I4,1X),F8.4)
112   FORMAT('TIME SLICE',T22,F10.4)
      GOTO 800

990   PRINT *,'ERROR IN OPENING FILE  IOSTAT = ',IOS
      GO TO 800
999   PRINT *,'ERROR IN READ  IOSTAT = ',IOS
```

```
800   CONTINUE
      STOP
      END
```

Appendix E

CPESIM II

Instructor Manual

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CPESIM II

Instructor Manual

1.0 Introduction

CPESIM II consists of a simulation of a major computer system and its operating environment. It was designed for use as a laboratory aid to allow students to apply Computer Performance Evaluation (CPE) tools and techniques to a "real" computer system. The use of an actual system for such studies is impractical for several reasons. First, due to the overhead and disruption caused by some measurement tools, their use in a real system for classroom purposes may be prohibited by computer center personnel. Second, if measurement data is available it may not be academically useful. That is, the system may be operating as it should (thus providing no problem solving opportunities), or it may contain several interacting problems which, although realistic, cannot practically be resolved by a student as a one-quarter course project. Third, if the data does allow the student to analyze a problem and recommend a solution, it is unlikely that the computer center will allow the implementation of the solution (or of several conflicting solutions from several students). CPESIM II solves these constraints be providing a simulated environment in which the student can gather whatever data is desired, analyze the data and recommend a solution, implement the solution (at an appropriate cost), and then analyze the modified system to verify whether or not the solution was effective.

CPESIM II consists of two parts. The heart of CPESIM II is a computer simulation (written in SLAM) of a large-scale computer system processing a workload, which executes on a host machine (e.g., the CYBER). Because it is a simulation, there are many simplifications and limitations which restrict its representation of reality. The second part of CPESIM II is a simulated operating environment for the computer system. This includes a computer-generated workload, a written scenario, budgetary constraints, and system data in a form that can be manipulated and analyzed by the student, playing the part of a CPE analyst and/or DP manager.

The written scenario provides the student with operating details about the particular computer installation he or she is to investigate. The instructor configures the hardware, operating system, and workload to illustrate a particular problem or situation. Measurement data is then provided to the student as requested for analysis and decision making on a periodic basis (e.g., weekly). In order to force the student analyst to make tradeoffs, only a subset of the available data can be accessed during a given period, and an appropriate cost is associated with each student request.

1.1 CPESIM II Output To Students

Many types of information are available to the student to aid in the analysis. Some of these are free and automatic. Some must specifically be requested. There is a cost associated with many. Some are mutually exclusive. The student must choose what data he wants and how he wants to use it. This section briefly describes the outputs available and directs the student to further information.

Manufacturer's Data - Literature (of varying value) describing hardware and software features is available in printed form.

Installation Documentation - In-house documentation of the local configuration, parameter values, modifications, problems, etc., may be available in printed form. These are specific to a given problem and will be provided as a separate handout.

Accounting System Data - The computer's accounting system files are available at no cost to the student as disk files on the host computer. Such data is in raw form, and the format is defined in the manufacturer's literature for the appropriate operating system.

Hardware Monitor - A hardware monitor exists for the simulated computer. However, such a monitor may have to be purchased or leased. Particular probe points and sampling periods must be specified by the student. As with a real hardware monitor, there is no effect on system performance. The output data is available as a disk file on the host computer.

Software Monitor - A software monitor is available for the simulated computer. However, it may have to be purchased or leased. As with real software monitors, these monitors require memory, runtime, and other system overhead to operate. Output data is available as disk files on the host computer.

Budget Reports - Periodic written summaries of the dollars spent will be available to the analyst.

1.2 Student Inputs to CPESIM II

One of the advantages of a simulation is that the students can make changes to the system. Thus, there are a number of inputs that the student may (or must) provide to CPESIM II (as well as some that he cannot). This section briefly describes the CPESIM II inputs available to the student.

Workload - Students have no control over the workload. The instructor does control the workload and may choose to vary it as the situation dictates (e.g., in response to a student initiated "user education program").

Interview Requests - Student analysts can submit written questions to installation personnel. Questions may or may not be answered. Charges for personnel time spent answering questions will be assessed to the student's account.

Monitor Purchase - Student analysts can submit purchase orders for the purchase of lease of any available hardware or software monitors.

Monitor Input Parameters - If the software monitor is desired then the students must provide the simulation the starting time, stopping time, and the queues to be monitored. If the hardware monitor is chosen then the starting time, stopping time, sample rate, counter probes, and timer probes must be specified. The student can input these parameters by using the "User" interface while making the configuration file.

Reconfiguration Requests - Students may request reconfiguration of existing hardware and operating system parameters. Personnel costs to reconfigure will be assessed. Degradation of system performance because of such changes will be frowned upon by installation management.

Purchase of System Options - Additional hardware or operating system modules may be purchased by submitting an appropriate purchase order. Costs will be assessed directly to the student account. Information on current cost and availability will be provided with each particular project.

Personnel Hiring - Requests for hiring additional installation personnel (e.g., for an additional shift) or for overtime authorization may be submitted. If approved, costs will be assessed directly to the student account.

1.3 Student Input For Grading

Of course, choice of grading technique is the prerogative of each individual instructor. However, this section describes one set of student inputs that may be used for that purpose.

Final Report - This represents the single most important input to the student's final grade. The report should be typewritten with drawings, tables, and graphs of professional quality. The report should consist of two parts. Part 1 is the Analyst's Report. This should include a clear statement of the problem as perceived, a systems analysis and description, stated hypothesis of the specific problem, analysis done to confirm (or deny) the hypothesis, recommended solution, and verification that the implemented solution solved the problem. Also, included should be a cost analysis and recommendations for the future. Part II is the Student's Critique. This should include an evaluation of the simulation as a learning tool along with a discussion of problems encountered and recommended changes.

Interim Reports - Various interim reports may be required throughout the quarter, depending on the scenario. These should be of the same quality as the final report and will count toward the project grade.

Software Tools - Some specific software tools (e.g., data reduction packages) may be required during the quarter. These will specifically count toward the project grade. For any other tools that the student might develop, the source code should also be submitted. These programs will influence the project grade.

Oral Presentation - Each team will be required to make a final oral presentation to the class and possibly an interim report as well. Although an important purpose of the oral report is to share each team's analysis and findings with the rest of the class, presentation is a graded part of the project and should be done in a professional manner.

1.4 Structure and CPESIM II Simulation

Figure 1 provides an overview of the CPESIM II system structure. The system can be divided into two sections. The first phase consists of generating two files, CONDES and EVSTR, needed by the simulation itself. CONDES is a file of parameters describing the simulated computer system. CONDES is created by a series of questions and answers from the user interface program (SETUP) prior to the simulation run. EVSTR is a file of synthetic job parameters, one record for each job, that provides a workload for the simulated system. Although EVSTR can come from anywhere (including the accounting log from a real computer), the program CRSTR provides a means of generating the workload from a set of workload description parameters, stored in file WRKDES. This program is very useful for generating artificial workloads for many uses other than CPESIM II. File WRKDES in turn, can be input from cards or from a permanent disk file.

The second part consists of the programs and files to execute the simulation itself. In the second phase the actual simulation programs, SIMS and SIMF, are used along with CONDES and EVSTR as input to generate performance data files ACTLOG and, optionally, HRDMON and SFTMON.

1.5 Paper Organization

The remainder of this report discusses the two phases in greater detail. Chapters 2 and 3 discuss the workload generation and configuration definition of phase 1, respectively. Chapter 4 discusses the phase 2 execution of the simulation.

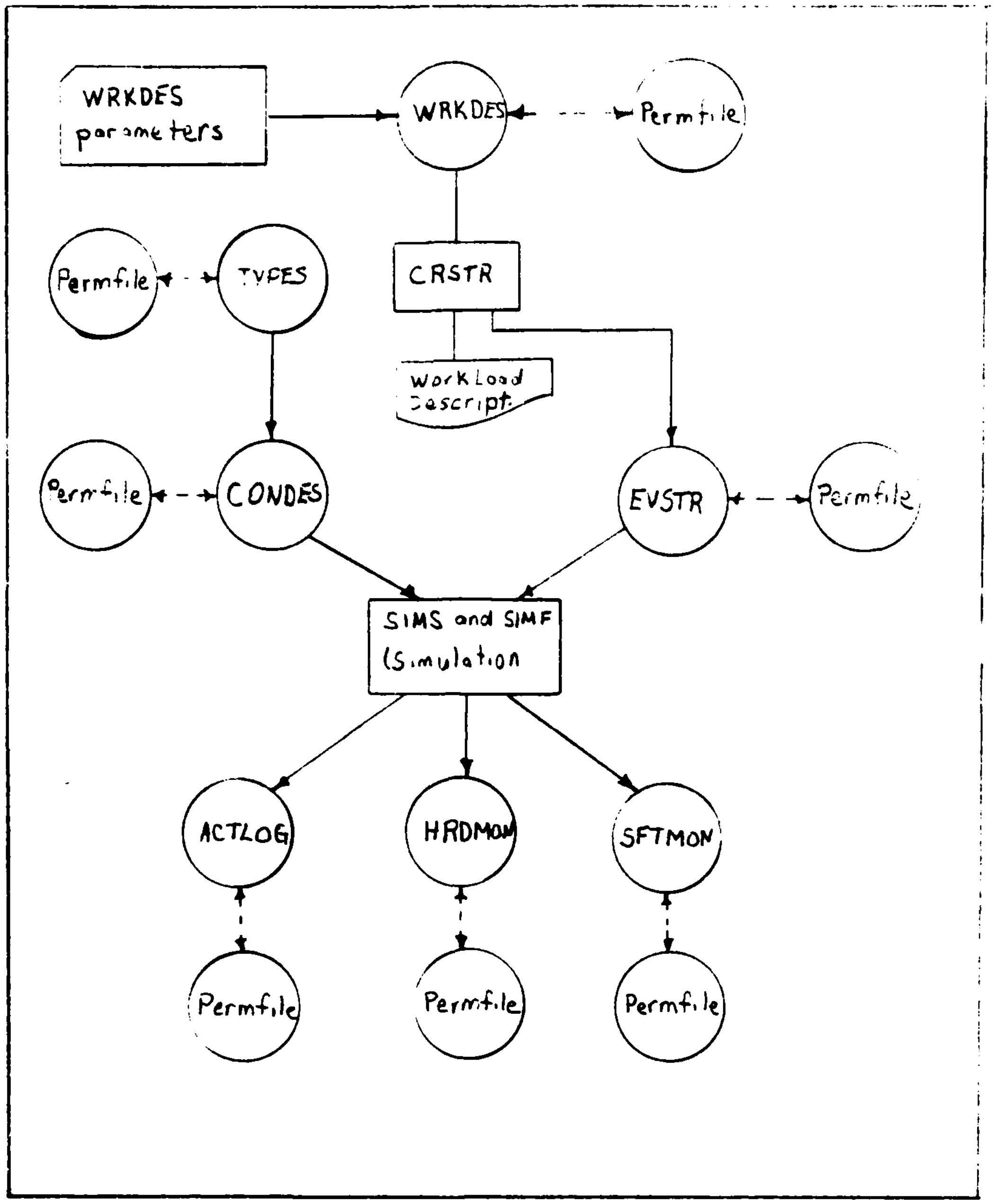

Fig 1. CPESIM II System Structure

2.0 Workload Generation

This section describes the workload generation process. It should be noted that this procedure can be used independently of the rest of CPESIM II to generate workloads for any simulation such as statistical data analysis, simulated operating systems, etc. The output workload consists of a sequence of simulated "jobs" where each job consists of a job identifier, an arrival time, and a series of computer resource requirements (e.g., CPU time, memory, etc.). These job parameters are based on user specified frequency distributions and associated parameters for each resource. These distributions can be changed at any time throughout a standard 24 hour day. The system can generate up to seven days of workload, but the sequence of distributions must be identical for each day (i.e., each day is statistically the same).

2.1 Workload Specification

Table 1 defines the input card images necessary to generate a workload. The actual generation program (CRSTR) reads these images from a disk file with local filename WRKDES. Thus, the user can load WRKDES from an actual card deck, or can create or change this file interactively. All of the input fields on all the cards are in a free-form format. This means that the information on the input cards does not need to be in a particular column. However, the order of the data is critical. Most of the information required is formatted so that a key word indicates the contents of the fields which follow it. The end of a card terminates a value for a field, but has no other effects. All fields must be separated by at least one space. All numerical information is entered as "real" numbers. This means all numbers must have a decimal point and a zero. If a decimal point is not present, the code which edits the input will generally reject the number, or assume a decimal point - not necessarily where it ought to be. All input fields have default values which are used if an input value has an error. Otherwise all data fields in a card should be used. A card may be dropped from the input if it is not required. A card is the basic input unit, and it consists of a keyword followed by a series of data fields. These logical cards may actually occupy more than one physical card.

The first card in this file, which is optional, is the DAY card, depicted in Table 1A. This card merely specifies the number of days of workload to be generated.

The second card is the SED card (Table 1B). This card specifies a seed for the random number generator. Program CRSTR uses this seed to generate several seeds for the different parameter distributions.

The third card of interest, shown in Table 1C is the TIM card. This card specifies a time (in decimal hours) at which the workload generating distributions are to be changed. These records must be in ascending time sequence in the workload creation deck. The parameter cards are thus interspersed among the TIM cards. The parameters which are defined prior to the first TIM card go into effect at hour 0.00 and continue to be in control unless another record defining the parameter appears. If more than one definition of the same parameter appears, the last definition for that time period is used. Only distributions that are changed by cards following this one will actually be changed. Other distributions will continue as they were before the specified TIM card. Any number of TIM cards my be included in a single 24-hour day. This same pattern of distribution will be used for each day of the workload.

The final card type is the parameter card. One of these cards, described in Table 1D, is used to specify each distribution. The first field specifies the variable to which the distribution is applied. The parameter options for the first field are listed in Table 1E. The second field specifies the distribution type, and the following fields list the distribution parameters. The allowable distribution types and required parameters are listed in Table 1E. Some of the data on the logical cards is in the form of probability distributions. The distributions are sequences of numbers structured as follows:

probability-of-the value   the value . . .

probability-of-the value   the value *

The sequence of number pairs is followed by an asterisk to indicate the end of the sequence (all variable length sequences of information are followed by an asterisk). The sequence may be spread across as many physical cards as desired. There are two types of distributions which may be specified in this manner. They are a probability density function or a cumulative distribution function. If a probability density function is specified, then the probabilities must add up to 1.0. If a cumulative distribution function is specified, then the first entry must be for the zero probability (even it is zero), the probabilities must be specified in ascending order, and the last probability must be 1.0.

Figure 2 illustrates an example of the WRKDES file for generating one day's data. The interarrival time card with a mean of 481 minutes followed by a TIM 8.0 is used to keep any jobs from arriving before 8:00. Thereafter all distributions are defined. The TIM 16.0 followed by the INT card with mean of 481 results in no job arrivals after 1600.

2.2 Program Execution

The sequence of workload specification cards described in Section 2.1 must be presented to the generating program CRSTR as a disk file under local filename WRKDES by copying a card deck from INPUT or attaching an appropriate permfile. The generating program itself, CRSTR, must be attached, as well as the system SIMSCRIPT library SIM2LIB. The output file from CRSTR has local filename EVSTR, and should be requested as a permanent file and declared as an 80 character file to the Cyber Record Manager. The CRSTR program can then be executed. Finally, the output file EVSTR should be cataloged. Figure 3 illustrated the Cyber control cards used in this sequence. The relation of data and program files can be seen in Figure 1.

2.3 Event Stream File EVSTR

The output of the workload generating program is a file EVSTR which is basically a sequence of arriving jobs sorted in order of arrival time. However, this file is intended as an input event stream to the main CPESIM II program, and actually consists of three event types: POWER.UP, JOB.ARRIVAL, and SWITCH.OFF, as described in Table 2. Each record is terminated by an "*". The first record, POWER.UP, and the last record, SWITCH.OFF, were used in the original CPESIM II, and are no longer used. They can be left in the file or be excluded as desired. The remaining records each represent an arriving job. The first field contains the character string JOB.ARRIVAL, and the remaining fields contain parameters for that job as defined in Table 2. The EVSTR file format is indicated in Table 3 for use by other programs. Note that this file is written by a SIMSCRIPT program, and arrival times less than one do not include a leading zero, hence the file may not be readable as is by a PASCAL program (if any jobs arrive prior to 1:00AM).

2.4 Other CRSTR Output

In addition to the event stream file, CRSTR also prints a workload description to the line printer (Cyber OUTPUT file). This information reflects the input WRKDES information, nicely formatted, as well as the total number of jobs created and the last day jobs arrived.

Table 1-A WORKLOAD CREATION INPUT;
DAY CARD (OPTIONAL)

FIELD	CONTENTS	VALUE(S)	DEFAULT	COMMENTS
1	Record Type	DAY	(Req)	NOTE 1
2	Num of Days	Integer	7.0	NOTE 2

NOTE 1: Indicates a day card. Used to identify the number of days the workload is to be created.

NOTE 2: The number of days a workload is to be created for.

Table 1-B WORKLOAD CREATION INPUT;
SEED CARD (OPTIONAL)

FIELD	CONTENTS	VALUE(S)	DEFAULT	COMMENTS
1	Record Type	SED	(Req)	NOTE 1
2	SEED	REAL	0.0	NOTE 2

NOTE 1: Indicates a random number generator seed card. Used to specify different starting seed for workload random number generation.

NOTE 2: The starting seed to be used.

Table 1-C WORKLOAD CREATION INPUT;
TIME CARD (OPTIONAL)

FIELD	CONTENTS	VALUE(S)	DEFAULT	COMMENTS
1	Record Type	TIM	(Req)	NOTE 1
2	Cutoff/Start Hour	Real	0.0	NOTE 2

NOTE 1: Indicates a time change input card. Used to delimit sections of a day when distrobutions apply.

NOTE 2: The hour at which the distributions prior to this card are replaced by the distributions which follow it. If a distribution is not replaced, it continues to control the output parameters. All distributions are initialized to default values at hour 0.0. When the input deck is read, the time of day is initialized to 0.0.

Table 1-D WORKLOAD CREATION INPUT;
PARAMETER CARDS

FIELD	CONTENTS	VALUE(S)	DEFAULT	COMMENTS
1	REC TYPE	See Table 1-E	(Required)	
2	Distribution Name	See Table 1-F	EXPONENT	NOTE 1
3	Distribution Parameters	See Table 1-F	1.0	

NOTE 1: The distribution which governs the parameter indicated by the record type.

Table 1-E PARAMETER VALUES FOR
FIELD 1 OF PARAMENTER CARDS

PARAMETER NAME	COMMENTS
INT	Interarrival time in minutes
CPU	CPU time in seconds
MEM	Memory required in 1K blocks
PRI	Priority in integer values greater than 1. Higher priority = lower value.
MTS	Number of allocatable devices
CRD	Number of input cards
LIN	Number of output lines
DIS	Number of system disk blocks
TAP	Number of allocated device blocks.

Table 1-F DISTRIBUTIONS AVAILABLE
FOR WORKLOAD DESCRIPTION

DISTRO NAME	PARAMETERS	COMMENTS
BETA	XPOWER X-1POWER	Generates a beta distobuted real numbers where XPOWER = power of x and X-1POWER = power of (1-x)
BINOMIAL	TRIALS PROBSUC	Generates integers representing the number of success in TRAILS independent trials when the probability of success is PROBSUC.
ERLANG	MEAN K	Generates Erlang distributed numbers with MEAN and K
EXPONENT	MEAN	Generates Exponentially distributed numbers with MEAN.
GAMMA	MEAN K	Generates a Gamma distibuted numbers with MEAN, and K
LOGNORMAL	MEAN STDDEV	Generates Lognormally distributed numbers with MEAN and standard deviation STDDEV.
NORMAL	MEAN STDDEV	Generates Normally distributed numbers with MEAN and standard deviation, STDDEV.

Table 1-F DISTRIBUTIONS AVAILABLE
FOR WORKLOAD DESCRIPTION (CONTINUED)

DISTRO NAME	PARAMETERS	COMMENTS
POISSON	MEAN	Generates Poisson distributed numbers with MEAN.
UNIFORM	LVAL HVAL	Generates Uniformly distributed numbers form LVAL to HVAL.
WEIBULL	SHAPE SCALE	Generates numbers from a Weibull distribution with a SHAPE parameter and a SCALE parameter.
STEP	VPROB VAL	Generates numbers from the values specified by VAL with probabilities VPROB. The VPROB values must form a probability distribution function or cumulative distribution function. A * must terminate the string of numbers.
LSTEP	VPROB VAL	Generates numbers linearly interprated from the values specified by VAL with probabilities VPROB. The VPROB values must form a valid cumulative distribution function. A * must terminate the string of numbers.

Table 2-A EVENT STREAM (EVSTR) FORMAT
POWER UP EVENT (Note 1)

FIELD	CONTENTS	VALUE(S)	COMMENTS
1	Event Type	POWER.UP	Indicates the starting time of the computer
2	Start Up Time	Real = 0	The time at which the computer is to start processing in hours
3	Record Term.	*	

NOTE 1: This card is no longer used by CPESIM II to start the
computer. It will not affect the simulation an!
can be left in the EVSTR file.

Table 2-B EVENT STREAM (EVSTR) FORMAT
JOB ARRIVAL EVENT

FIELD	CONTENTS	VALUE(S)	COMMENTS
1	Event Type	JOB.ARRIVAL	Indicates arrival of a job for the computer to process.
2	Arrival time	Real 0	Arrival time in hours.
3	Job Name	Integer	Unique job indentifier.
4	CPU Time	Integer	CPU time required in seconds.
5	Memory	Integer	Blocks of memory needed.
6	Priority	Integer1	Job priority. Lower value = higher priority.
7	Allocatable Devices	Integer	Number of devices required.
8	Cards	Intger	Number of input cards.
9	Lines	Integer	Number of lines outputed
10	Disk Blocks	Integer	Number of disk blocks job reads/writes.
11	Allocatable Device Blocks	Integer	Number of blocks job reads/writes to allocated devices.
12	Record Term	*	

Table 2-C EVENT STREAM (EVSTR) FORMAT
SWITCH OFF EVENT (Note 1)

FIELD	CONTENTS	VALUE(S)	COMMENTS
1	Event Type	SWITCH.OFF	Indicates the stopping time of the computer
2	Start Up Time	Real = 0	The time at which the computer is to stop processing in hours
3	Record Term.	*	

NOTE 1: CPESIM II no longer uses this card to process the end of the job stream. The simulation ignores this card and can be left in EVSTR.

Table 3 EVSTR Format For Job Records

FIELD	VARIABLE	FORMAT
1	JOB.ARRIVAL	A12 (left justified)
2	Arrival Time	F10.4,1X
3	Job Name	I10,1X
4	CPU Time	I3,1X
5	Memory	I3,1X
6	Priority	I2,1X
7	Alloc. Devices	I2,1X
8	Cards	I4,1X
9	Lines	I5,1X
10	Disk Blocks	I4,1X
11	Alloc. Device Blocks	I4,1X
12	*	1A

```
SED 680
DAY 1.0
INT STEP 1.0 481.0 *
TIM 8.0
INT EXPONENT 3.0
CPU EXPONENT 160.0
MEM LSTEP  0.0     10.0   0.1     16.0  0.19   20.0
           0.19    25.0   0.029   30.0  0.32   35.0
           0.38    50.0   0.57    63.0  0.76   70.0
           0.76   100.0   0.855  124.0  0.95  150.0
           0.95   190.0   1.0    205.0  *
PRI STEP 1.0 2.0 *
MTS STEP 1.0 0.0 *
CRD EXPONENT 10.0
LIN EXPONENT 10.0
DIS EXPONENT 1000.0
TAP STEP 1.0 0.0 *
TIM 13.0
CPU EXPONENT 500.0
TIM 16.0
INT STEP 1.0 481.0 *
```

Fig 2. Example of WRKDES File

```
CP2, STCB.  T780510, HARTRUM, 53450
ATTACH, WRKDES, WRKDS1, ID=EE752.
ATTACH, SIM2LIB, ID=CACI, SN=SYSTEM.
ATTACH, CRSTR, CRSTR, ID=LEWIS.
REQUEST, EVSTR, *PF.
FILE(EVSTR, FL=80)
CRSTR, SIMU9=EVSTR, SIMU5 = WRKDES.
RETURN, CRSTR.
REWIND, EVSTR.
CATALOG, EVSTR, WRKLD1, ID=EE752, RP=90,XR=TCH.
COPYSBF, EVSTR, OUTPUT.
*EOF
```

Fig 3. Cyber JCL to Execute CRSTR

3. Configuration Definition

In addition to an input workload, the CPESIM II simulator also needs to know the current system configuration. This section describes how the user specifies the configuration. The simulation program uses a configuration file with the local name CONDES. This file can be entered from a remote terminal. The CONDES file contains information on the hardware devices (disks, CPU, etc.), hardware interconnections, operating system parameters (partition sizes, etc), hardware monitor connections, and software monitor parameters. This section discusses each of these areas.

3.1 Hardware/Software Architecture Definition

The first records of interest in the CONDES file define the hardware, operating system parameters, and interconnections of the computer system being simulated. These records are defined in Table 4A through 4K, and must be entered in the file in the order listed in Table 4L. These records, as indicated in the first field of each, deal with the CPU, with memory, with each IOC (I/O channel), and with each I/O device.

The first three records deal with the cpu. The first record indicates the number of cpus that will be in the simulation. The second contains the cpu name, the cpu ratio which is used to simulate relative speeds of different processors, and the cpu cost. If the ratio has a value of 1.0 each job will require the same amount of CPU time as is specified in that job's resource requirement in the EVSTR file. A faster processor would be simulated by using a CPU ratio of a less than 1.0. Thus this parameter is the ratio of the actual processing time to the requested processing time. Typically this value would be initially set to 1.0, then varied on later runs to reflect replacement of the CPU with a faster or slower (and cheaper) CPU. The third record, sets the round robin time quantum. This parameter sets the number of seconds that each job will execute before yielding the CPU to another job. Note that if a job requests an I/O before this time is reached it will yield the CPU at that time. By setting this parameter to a very large number, FIFO service can be modeled. CAUTION: Since this simulation distributes disk and tape I/Os evenly across a job's runtime, if the average time between I/O requests is less than the round robin time quantum, then for most jobs the latter parameter becomes irrelevant, and the system will behave as though it uses FIFO.

The second set of records describes the memory partitions of the simulated computer. The first card lists the number of memory partitions that the system will have (maximum of 20 partitions). The number of memory partitions also determines the multiprogramming level. Each job (except the job scheduler) is allocated a memory partition prior to being released into the execute queue. Since the job scheduler is always core resident in system memory, the multiprogramming level is one plus the number of memory partitions. After the number of memory partitions is entered, the size of each partition is entered (one per record). The size of the memory partitions are entered in terms of 1024 byte blocks. The order of the memory partitions <u>IS</u> important. When the job scheduler executes it tries to fit the job in the first free memory partition. If the partition is not large enough it looks at the next partition, followed by the next, until a partition of sufficient size is found or there are no more available partitions. Because of this searching algorithm the partitions should be listed in ascending order by size. By having them listed in this way, the smallest available partition will be used for each particular job. Also note, if a job requires more memory than is available in the largest memory partition, the job will sit in the hold queue until the end of the simulation.

The next set of records define the Input/Output Controllers (IOCs). The first record defines the number of controllers that the simulation will have. A maximum of five IOCs can be defined in any one simulation run. The next records specify the IOC name, the data transfer rate, and the cost. The rate will be in terms of standard data blocks per second. The data rate must be specified as an integer number of data blocks since fractions of blocks are not allowed. The IOC data transfer rate is the maximum number of blocks that an IOC can handle from I/O devices at one particular time. For example, if an IOC with a transfer speed of 100 blocks per second is connected to three devices with device transfer speeds of 40 blocks per second, two of those devices could be active simultaneously with no delay, while a transfer over the third device would have to put in the IOC queue.

After the definition of the IOCs, the I/O devices are defined. The first group of I/O devices defined are unallocatable I/O devices (disks and drums). The first record will specify the number of unallocated devices (maximum of 10). The following records will define each individual I/O device. The first field is the name of the device. The second field is the data transfer rate. This field must be specified in terms of the amount of time (in seconds) required to transfer a 1K block of data. The third field represents the cost of the device. The last five fields define the connection of the device with the IOCs. A "1" in field 1 will indicate that the device is connected to the the first channel, where as a "0" will indicate the device is not connected to the IOC. The next 4 fields represent IOCs 2 through 5, respectively. There must be one channel definition card for each allocatable device.

The next group of I/O device definition cards define the allocatable I/O devices (tapes). The allocatable I/O devices are defined in exactly the same manner as the unallocatable I/O devices.

The third type of I/O device defined is the card reader. The first field is the name of the card reader. The second and third fields define the speed and cost of the card reader. The card reader's speed is defined in terms of cards read per minute. The simulation then calculates the transfer rate by dividing the 1K block size by the card record size (80 bytes). This result is then truncated to an integer and divided into the card reader speed. The result is now in terms of how long it takes to load a 1K buffer. This result is then multiplied by 60 to get the transfer rate in seconds instead of minutes. The last five fields define the interface between the reader and the IOCs. The format for the channel connections is the same as the unallocatable devices.

The last I/O device defined is the line printer. The line printer's name, speed, and cost are represented by the first three fields. The line printer's speed is defined in terms of lines per minute. Like the card reader, the transfer rate of the printer is calculated by finding the number of 132 byte lines that can fit in the 1K buffer and dividing by the number of lines per minutes. This result is then converted to a transfer rate in terms of seconds. The last five fields define the channel connections in the same way as the previous I/O devices.

3.2 <u>Hardware and Software Monitors</u>

The present configuration of the simulation requires that the software and hardware monitors be defined in the CONDES file. The software monitor requires four cards to define its parameters. A 'Y' in the first card tells the simulation if the software monitor is desired. If the software monitor is desired then the next three cards will define the monitor's parameters. (NOTE: If the software monitor is not desired then the next three cards are not inserted into the CONFIG file and the hardware monitor cards follow the 'N' card for the software monitor.) The second and third cards define the starting and stopping time of the monitor. These cards have four fields which correspond to the desired day, hour, minute and second for the starting or stopping time of the monitor. NOTE: The starting time is the time at which the monitor is entered into the hold queue. The actual monitor trace will not start until the monitor is executed by the cpu. The fourth card defines the five queues which will be monitored. The software monitor can monitor any queue in the simulated system. The number of the desired queue is entered into each of the five fields. The queue numbers are listed in Table 4-J. If less than five queues are to be monitored any illegal queue number can be substituted in one of the queue fields.

The definition of the hardware monitor is similar to the software monitor. The first card tells the simulation if the hardware monitor is desired. If the monitor is desired the next two cards specify the starting and stopping times. The last card defines the two timer probes and the three counter probes. These probes can be connected to the cpus, IOCs and I/O devices. If one or more probes is not desired, then an illegal probe connection point is entered into that probe's field. Legal probe points are listed in Table 4-K.

3.3 Generating a CONDES File

The CONDES file must have the records in the proper format and in the order listed in Table 4-L. These records can be entered by hand or they can be generated by using the "User" interface. The file SETUP provides this "USER" interface. This file reads the hardware descriptions from a file called TYPES. From the data provided by TYPES, the user will be queried about the types and quantities of various pieces of equipment. From the user's responses a CONDES file will be generated. This file can then be used as input to the simulation. Figure 4 shows the PROCFIL used to execute the "User" interface. The file TYPES must be stored on disk prior to its being called. Typically the instructor will control the TYPES file. He would list all the scenario hardware in this file. By controlling the file, the students can choose only "legal" pieces of equipment from which to define their system. The format for the TYPES file is listed in Table 5-A through 5-F. The order of the cards must be as specified in Table 5-G. Figure 6 illustrates the contents of a typical CONDES file generated by SETUP using the TYPES file listed in Figure 5.

Table 4-A CONFIGURATION INPUT;
CPU CARDS

NUMBER OF CPUS CARD

FIELD	VARIABLE	FORMAT	COMMENTS
1	Num of CPUs	I2	

CPU DESCRIPTION CARD

FIELD	VARIABLE	FORMAT	COMMENTS
1	Name of CPU	A20,1X	
2	CPU Ratio	F10.4,1X	Relative CPU speed. .5 twice as fast as 1.0
3	CPU Cost	F8.2,1X	Cost of each CPU in $.

CPU TIME SLICE CARD

FIELD	VARIABLE	FORMAT	COMMENTS
1	TIME SLICE	A20,1X	Indicates time slice card
2	Time Slice	F10.4	Round robbin time quantum.

Table 4-B CONFIGURATION INPUT;
MEMORY CARDS

NUMBER OF MEMORY PARTITIONS

FIELD	VARIABLE	FORMAT	COMMENTS
1	Number of Partitions	I2	Maximum of 20 memory partitions

MEMORY PARTITION SIZE CARD (One for Each Partition)

FIELD	VARIABLE	FORMAT	COMMENTS
1	Name of Partition	A20,1X	
2	Partition Size	F10.4	Size in terms of 1024 byte blocks quantum.

Table 4-C CONFIGURATION INPUT;
CHANNEL CARDS

NUMBER OF CHANNELS

FIELD	VARIABLE	FORMAT	COMMENTS
1	Number of Channels	I2	Maximum of 5 channels

CHANNEL DESCRIPTION CARD (One per Channel)

FIELD	VARIABLE	FORMAT	COMMENTS
1	Name of Channel	A20,1X	
2	Channel Data Rate	F10.4,1X	Number of 1K blocks channel can transfer in in one second.
3	Channel Cost	F8.2,1X	Cost of channel in $.

Table 4-D CONFIGURATION INPUT;
DISK CARDS

NUMBER OF DISKS

FIELD	VARIABLE	FORMAT	COMMENTS
1	Number of Disks	I2	Maximum of 10 disks

DISK DESCRIPTION CARD (One per Disk)

FIELD	VARIABLE	FORMAT	COMMENTS
1	Name of Disk	A20,1X	
2	Disk Data Rate	F10.4,1X	Time in seconds to transfer a 1K block of data.
3	Disk Cost	F8.2,1X	Cost of disk in $.
4	Channel 1 Connection	I1,1X	1 indicates disk connected to channel 1
5	Channel 2 Connection	I1,1X	1 indicates disk connected to channel 2
6	Channel 3 Connection	I1,1X	1 indicates disk connected to channel 3
7	Channel 4 Connection	I1,1X	1 indicates disk connected to channel 4
8	Channel 5 Connection	I1,1X	1 indicates disk connected to channel 5

Table 4-E CONFIGURATION INPUT;
TAPE CARDS

NUMBER OF TAPES

FIELD	VARIABLE	FORMAT	COMMENTS
1	Number of Tapes	I2	Maximum of 10 tapes

TAPE DESCRIPTION CARD (One per Tape)

FIELD	VARIABLE	FORMAT	COMMENTS
1	Name of Tape	A20,1X	
2	Tape Data Rate	F10.4,1X	Time in seconds to transfer a 1K block of data.
3	Tape Cost	F8.2,1X	Cost of tape in $.
4	Channel 1 Connection	I1,1X	1 indicates tape connected to channel 1
5	Channel 2 Connection	I1,1X	1 indicates tape connected to channel 2
6	Channel 3 Connection	I1,1X	1 indicates tape connected to channel 3
7	Channel 4 Connection	I1,1X	1 indicates tape connected to channel 4
8	Channel 5 Connection	I1,1X	1 indicates tape connected to channel 5

Table 4-F CONFIGURATION INPUT;
CARD READER DESCRIPTION CARD

FIELD	VARIABLE	FORMAT	COMMENTS
1	Name of Card Reader	A20,1X	
2	Card Reader Data Rate	F10.4,1X	Number of cards read per minute
3	Card Reader Cost	F8.2,1X	Cost of reader in $.
4	Channel 1 Connection	I1,1X	1 indicates connected to channel 1
5	Channel 2 Connection	I1,1X	1 indicates connected to channel 2
6	Channel 3 Connection	I1,1X	1 indicates connected to channel 3
7	Channel 4 Connection	I1,1X	1 indicates connected to channel 4
8	Channel 5 Connection	I1,1X	1 indicates connected to channel 5

Table 4-G CONFIGURATION INPUT;
LINE PRINTER DESCRIPTION CARD

FIELD	VARIABLE	FORMAT	COMMENTS
1	Name of Line Printer	A20,1X	
2	Line Printer Data Rate	F10.4,1X	Number of line printed per minute
3	Line Printer Cost	F8.2,1X	Cost of printer in $.
4	Channel 1 Connection	I1,1X	1 indicates connected to channel 1
5	Channel 2 Connection	I1,1X	1 indicates connected to channel 2
6	Channel 3 Connection	I1,1X	1 indicates connected to channel 3
7	Channel 4 Connection	I1,1X	1 indicates connected to channel 4
8	Channel 5 Connection	I1,1X	1 indicates connected to channel 5

Table 4-H CONFIGURATION INPUT;
SOFTWARE MONITOR CARDS

SOFTWARE MONITOR EXECUTION CARD

FIELD	VARIABLE	FORMAT	COMMENTS
1	S/W Monitor Desired	A1	´Y´ indicates that the monitor is desired. ´N´ indicates not desired.

SOFTWARE MONITOR START UP CARD
(Required if S/W Monitor Card is ´Y´)

FIELD	VARIABLE	FORMAT	COMMENTS
1	Starting Day	T22,I4,1X	Starting day of run.
2	Starting Hour	I4,1X	Starting hour of run.
3	Starting Min.	I4,1X	Starting minute of run.
4	Starting Sec.	F8.4	Starting second of run.

SOFTWARE MONITOR TERMINATION CARD
(Required if S/W Monitor Card is ´Y´)

FIELD	VARIABLE	FORMAT	COMMENTS
1	Stopping Day	T22,I4,1X	Stopping day of run.
2	Stopping Hour	I4,1X	Stopping hour of run.
3	Stopping Min.	I4,1X	Stopping minute of run.
4	Stopping Sec.	F8.4	Stopping second of run.

Table 4-H CONFIGURATION INPUT;
SOFTWARE MONITOR CARDS (Continued)

SOFTWARE MONITOR QUEUE CARD
(Required if H/W Monitor Card is 'Y')

FIELD	VARIABLE	FORMAT	COMMENTS
1	Queue #1	I2,1X	First queue to be monitored. See Table 4-J
2	Queue #2	I2,1X	Second queue to be monitored. See Table 4-J
3	Queue #3	I2,1X	Third queue to be monitored. See Table 4-J
4	Queue #4	I2,1X	Fourth queue to be monitored. See Table 4-J
5	Queue #5	I2,1X	Fifth queue to be monitored. See Table 4-J

Table 4-I CONFIGURATION INPUT;
HARDWARE MONITOR CARDS

HARDWARE MONITOR EXECUTION CARD

FIELD	VARIABLE	FORMAT	COMMENTS
1	H/W Monitor Desired	A1	´Y´ indicates that the monitor is desired. ´N´ indicates not desired.

HARDWARE MONITOR START UP CARD
(Required if H/W Monitor Card is ´Y´)

FIELD	VARIABLE	FORMAT	COMMENTS
1	Starting Day	T22,I4,1X	Starting day of run.
2	Starting Hour	I4,1X	Starting hour of run.
3	Starting Min.	I4,1X	Starting minute of run.
4	Starting Sec.	F8.4	Starting second of run.

HARDWARE MONITOR TERMINATION CARD
(Required if H/W Monitor Card is ´Y´)

FIELD	VARIABLE	FORMAT	COMMENTS
1	Stopping Day	T22,I4,1X	Stopping day of run.
2	Stopping Hour	I4,1X	Stopping hour of run.
3	Stopping Min.	I4,1X	Stopping minute of run.
4	Stopping Sec.	F8.4	Stopping second of run.

Table 4-I CONFIGURATION INPUT;
HARDWARE MONITOR CARDS (Continue)

HARDWARE MONITOR SAMPLE RATE CARD
(Required if H/W Monitor Card is ´Y´)

FIELD	VARIABLE	FORMAT	COMMENTS
1	Sampler Rate	T22,F10.4	How ofter the monitor will record data and clear counter and timers

HARDWARE MONITOR PROBE CARD
(Required if H/W Monitor Card is ´Y´)

FIELD	VARIABLE	FORMAT	COMMENTS
1	Timer #1	I2,1X	First timer probe connection. See Table 4-K
2	Timer #2	I2,1X	Second timer probe connection. See Table 4-K
3	Count #1	I2,1X	First counter probe connection. See Table 4-K
4	Count #2	I2,1X	2nd counter probe connection. See Table 4-K
5	Count #3	I2,1X	Third counter probe connection. See Table 4-K

Table 4-J CONFIGURATION INPUT;
SOFTWARE MONITOR QUEUES

QUEUE #	QUEUE NAME	QUEUE #	QUEUE NAME
1.	INPUT	2.	HOLD
3.	EXEC	4.	OUTPUT
11.	TAPE 1	12.	TAPE 2
13.	TAPE 3	14.	TAPE 4
15.	TAPE 5	16.	TAPE 6
17.	TAPE 7	18.	TAPE 8
19.	TAPE 9	20.	TAPE 10
21.	DISK 1	22.	DISK 2
23.	DISK 3	24.	DISK 4
25.	DISK 5	26.	DISK 6
27.	DISK 7	28.	DISK 8
29.	DISK 9	30.	DISK 10
31.	CHAN 1	32.	CHAN 2
33.	CHAN 3	34.	CHAN 4
35.	CHAN 5		
36.	NO QUEUE DESIRED		

Table 4-K CONFIGURATION INPUT;
HARDWARE MONITOR PROBE POINTS

QUEUE #	QUEUE NAME	QUEUE #	QUEUE NAME
1.	CPU	2.	READER
3.	PRINTER	11.	TAPE 1
12.	TAPE 2	13.	TAPE 3
14.	TAPE 4	15.	TAPE 5
16.	TAPE 6	17.	TAPE 7
18.	TAPE 8	19.	TAPE 9
20.	TAPE 10	21.	DISK 1
22.	DISK 2	23.	DISK 3
24.	DISK 4	25.	DISK 5
26.	DISK 6	27.	DISK 7
28.	DISK 8	29.	DISK 9
30.	DISK 10	31.	CHAN 1
32.	CHAN 2	33.	CHAN 3
34.	CHAN 4	35.	CHAN 5
36.	NO DEVICE DESIRED		

Table 4-L CONFIGURATION INPUT;
ORDER OF INPUT CARDS

CARD NAME	COMMENTS
NUMBER OF CPUS	
CPU DESCRIPTION	
CPU TIME SLICE	
NUMBER OF PARTITIONS	
MEMORY PARTITION SIZE	ONE PER PARTITION
NUMBER OF CHANNELS	
CHANNEL DESCRIPTION	ONE PER CHANNEL
NUMBER OF DISKS	
DISK DESCRIPTION	ONE PER DISK
NUMBER OF TAPES	
TAPE DESCRIPTION	ONE PER TAPE
CARD READER DESCRIPT.	
LINE PRINTER DESCRIPT.	
S/W MONITOR EXECUTION	
S/W MONITOR START UP	MANDITORY IF EXECUTION WAS INDECATED BY 'Y' IN EXECUTION CARD
S/W MONITOR TERMINATION	MANDITORY IF EXECUTION WAS INDICATED BY 'Y' IN EXECUTION CARD
S/W MONITOR QUEUE	MANDITORY IF EXECUTION WAS INDICATED BY 'Y' IN EXECUTION CARD
H/W MONITOR EXECUTION	
H/W MONITOR START UP	MANDITORY IF EXECUTION WAS INDICATED BY 'Y' IN EXECUTION CARD
H/W MONITOR TERMINATION	MANDITORY IF EXECUTION WAS INDICATED BY 'Y' IN EXECUTION CARD
H/W MONITOR SAMPLE RATE	MANDITORY IF EXECUTION WAS INDICATED BY 'Y' IN EXECUTION CARD
H/W MONITOR PROBE	MANDITORY IF EXECUTION WAS INDICATED BY 'Y' IN EXECUTION CARD

Table 5-A TYPES INPUT;
DISK CARDS

NUMBER OF DISKS TYPES

FIELD	VARIABLE	FORMAT	COMMENTS
1	Number of Disks Types	I2	

DISK DESCRIPTION CARD (One Per Type)

FIELD	VARIABLE	FORMAT	COMMENTS
1	Name of Disk	A20,1X	
2	Disk Data Rate	F10.4,1X	Time in seconds to transfer a 1K block of data.
3	Disk Cost	F8.2,1X	Cost of disk in $.

Table 5-B TYPES INPUT;
TAPE CARDS

NUMBER OF TAPE TYPES

FIELD	VARIABLE	FORMAT	COMMENTS
1	Number of Tape Types	I2	

TAPE DESCRIPTION CARD (One Per Type)

FIELD	VARIABLE	FORMAT	COMMENTS
1	Name of Tape	A20,1X	
2	Tape Data Rate	F10.4,1X	Time in seconds to transfer a 1K block of data.
3	Tape Cost	F8.2,1X	Cost of tape in $.

Table 5-C TYPES INPUT; CHANNEL CARDS

NUMBER OF CHANNEL TYPES

FIELD	VARIABLE	FORMAT	COMMENTS
1	Number of Channel Types	I2	

CHANNEL DESCRIPTION CARD (One Per Type)

FIELD	VARIABLE	FORMAT	COMMENTS
1	Name of Channel	A20,1X	
2	Channel Data Rate	F10.4,1X	Number of 1K blocks channel can transfer in in one second.
3	Channel Cost	F8.2,1X	Cost of channel in $.

Table 5-D TYPES INPUT;
CARD READER CARDS

NUMBER OF CARD READER TYPES

FIELD	VARIABLE	FORMAT	COMMENTS
1	Number of Reader Types	I2	

CARD READER DESCRIPTION CARD (One Per Type)

FIELD	VARIABLE	FORMAT	COMMENTS
1	Name of Card Reader	A20,1X	
2	Card Reader Data Rate	F10.4,1X	Number of cards read per minute
3	Card Reader Cost	F8.2,1X	Cost of reader in $.

Table 5-E TYPES INPUT;
LINE PRINTER CARDS

NUMBER OF LINE PRINTER TYPES

FIELD	VARIABLE	FORMAT	COMMENTS
1	Number of Printer Types	I2	

LINE PRINTER DESCRIPTION CARD (One Per Type)

FIELD	VARIABLE	FORMAT	COMMENTS
1	Name of Line Printer	A20,1X	
2	Line Printer Data Rate	F10.4,1X	Number of lines printed per minute
3	Line Printer Cost	F8.2,1X	Cost of printer in $.

Table 5-F TYPES INPUT;
CPU CARDS

NUMBER OF CPU TYPES CARD

FIELD	VARIABLE	FORMAT	COMMENTS
1	Number of CPU types	I2	

CPU DESCRIPTION CARD (One Per Type)

FIELD	VARIABLE	FORMAT	COMMENTS
1	Name of CPU	A20,1X	
2	CPU Ratio	F10.4,1X	Relative CPU speed. .5 twice as fast as 1.0
3	CPU Cost	F8.2,1X	Cost of each CPU in $.

Table 5-G TYPES INPUT;
ORDER OF INPUT CARDS

CARD NAME	COMMENTS
NUMBER OF DISK TYPES	
DISK DESCRIPTION	One Per Type
NUMBER OF TAPE TYPES	
TAPE DESCRIPTION	One Per Type
NUMBER OF CHANNEL TYPES	
CHANNEL DESCRIPTION	One Per Type
NUMBER OF READER TYPES	
CARD READER DESCRIPTION	One Per Type
NUMBER OF PRINTER TYPES	
LINE PRINTER DESCRIPTION	One Per Type
NUMBER OF CPUS	
CPU DESCRIPTION	One Per Type

```
.PROC,SETUP.
ATTACH,TYPES.
REWIND,TYPES.
ATTACH,SETUP.
REQUEST,CONFIG,*PF.
FTN5,I=SETUP,LO=0,ANSI=0,DB.
CONNECT,INPUT,OUTPUT.
LGO.
CATALOG,CONFIG,CONFIG,RP=999.
RETURN,TYPES,SETUP,INPUT,OUTPUT,CONFIG.
```

Fig 4. "User" Interface Procfil

```
3
DISK 1                    0.0328  1000.00
DISK 2                    0.0656   500.00
DRUM 1                     .0108  3000.00
1
TAPE 1                    0.0725   250.00
2
CHANNEL 1               500.00    1100.00
CHANNEL 2               200.00     620.00
2
CARD READER 1            80.00      30.40
CARD READER 2          1000.00     400.00
2
PRINTER 2              1000.00     500.00
LASER PRINTER          4000.00    3000.00
2
CPU 1                     1.00    1110.00
CPU 2                      .95    4000.00
```

Fig 5. Typical TYPES File

```
 2
CPU 1                         1.0000  1110.00
TIME SLICE                    1.0000
 5
PARTITION  1                  4.0000
PARTITION  2                100.0000
PARTITION  3                100.0000
PARTITION  4                200.0000
PARTITION  5                700.0000
 2
CHANNEL 2                   200.0000   620.00
CHANNEL 1                   500.0000  1100.00
 2
DISK 2                         .0656   500.00  1 1 0 0 0
DRUM 1                         .0108  3000.00  0 1 0 0 0

TAPE 1                         .0725   250.00  1 1 0 0 0
CARD READER 2              1000.0000   400.00  1 0 0 0 0
LASER PRINTER              4000.0000  3000.00  1 0 0 0 0
Y
S/W MONITOR START             0    12     0    0.0000
S/W MONITOR STOP              2     0     0    0.0000
 3  1 11 31 36
N
```

Fig 6. Typical CONDES File

4.0 Simulation Execution

With the WRKDES and CONDES files available, the actual simulation can be run. Section 5 discusses the simulation output. However, since the output files must be cataloged as part of the execution run and are typically printed at that time, the JCL associated with the simulation output is presented in this section.

4.1 File Storage

In order to allow students to develop and use software data analysis tools, the output files from the simulation should be stored as perm files. This output consists of three files for each student group. Because of directory limitations under NOS-BE, the following approach is suggested to prevent loss of the simulation output due to a full directory. A dummy perm file is created for each student group before the simulation run. Note that each could specify its own protection password at this point if such security were felt to be needed. Then at the end of the simulation run, the output files are cataloged as cycles 2, 3, and 4 of this dummy file. Typically a retention time of 5 days might be specified. This accomplishes two things. First, it is necessary to delete cycles 2, 3, and 4 before the next run, as the cyber is limited to five cycles of any filename. Second, it forces the students to decide what data is really worth saving in machine form, copying and saving those files themselves, and allowing unused data to leave the system. Figure 7 shows the JCL to create dummy files for three student groups.

4.2 Simulation Execution

The JCL for a simulation run is shown in Figure 8. It is necessary to attach the network portion of the model (SIMS), the discrete portion of the model (SIMF), as well as the CONDES file and the EVSTR file. In order to record data to the accounting file, the hardware monitor file, and the software monitor file, three files have to be requested for permanent file space. After the execution of the model, the three files will be permanently stored on the disk. The data is now ready for further data reduction.

Typically (in the CPE course) one run is made per week. During the first few weeks, only one run per class is made while the students gather sufficient data for decision making. Once the students want to change the configuration, or look at different variables with the monitors, then a separate run is required for each group. Because of the run times involved, the running of the program should be done by the instructor.

4.3 Modifying the Simulation Run Time

The simulation is presently set up to run from 0 to 600,000 seconds of simulated time (approximately 7 days). If it is desired to run the simulation at sum other amount of time then the file SIMS has to be modified. The only card that has to be modified is the "INIT" card, which is the third card from the end of the file. The INIT card has the following format:

```
INIT,start-time,stop-time;
```

where start-time and stop- ime are real variables representing the precise second that the simulation is to start and stop.

```
CP4,STCSB.  T780510, HARTRUM, 53450
REQUEST, A, *PF.
REQUEST, B, *PF.
REQUEST, C, *PF.
COPYCR, INPUT, A.
COPYCR, INPUT, B.
COPYCR, INPUT, C.
CATALOG,A,GROUP1,ID=EE752,RP=90,XR=XXX.
CATALOG,B,GROUP2,ID=EE752,RP=90,XR=XXX.
CATALOG,C,GROUP3,ID=EE752,RP=90,XR=XXX.
*EOR
GROUP 1 DATA.
*EOR
GROUP 2 DATA.
*EOR
GROUP 3 DATA.
*EOR
*EOF
```

Fig 7. Cyber JCL to Load Dummy Files

```
OWE,T70,I0200,CM220000.    T830617,OWEN,55533
ATTACH,PROC,SLAMPROC,ID=AFIT,SN=AFIT.
ATTACH,SIMS,SIMS.
ATTACH,SIMF,SIMF.
ATTACH,TAPE11,TAPE11.
REQUEST,TAPE12,*PF.
REQUEST,TAPE13,*PF.
REQUEST,TAPE14,*PF.
ATTACH,TAPE15,CONFIG.
FTN5(I=SIMF,ANSI=0).
BEGIN,SLAMII,PROC,M=LGO,PMD=1,PL=10000,MAP=PART,I=SIMS.
CATALOG,TAPE12,ACTLOG.
CATALOG,TAPE13,HRDMON.
CATALOG,TAPE14,SFTMON.
*EOR
*EOF
```

Fig 8. Cyber JCL to Execute Simulation

5.0 Simulation Output

There are three basic output files generated by SIMS and SIMF. This section briefly addresses these three files.

5.1 Accounting Data

The accounting data is generated directly by every run of the simulation. This file is under the local filename of TAPE12. There is one record for each job that has gone through the system. The record content and format is listed in Table 6. At the end of the simulation the local accounting file (TAPE12) is cataloged as ACTLOG. The file is now ready for post processing by the student.

5.2 Software Monitor Data

Software monitor data is generated only if the CONDES file has requested the software monitor. The monitor records the length of time a job spends in a queue, where the job came from and where the job is going after exiting the queue. The monitor will record the data for all the jobs that go through the five queues specified in the CONDES file. The software monitor file will be cataloged as SFTMON at the end of the simulation run. The record content and format is listed in Table 7.

5.3 Hardware Monitor Data

Hardware monitor data is generated only if the CONDES file has requested the hardware monitor. The hardware monitor records the amount of time that a timer probe was energized, and the number of times that a counter probe was energized. The counters and timers are reset after every hardware monitor sample rate cycle. At the end of the simulation the file is cataloged as HRDMON. The record content and format is listed in Table 8.

Table 6 ACTLOG Record Format

FIELD	VARIABLE	FORMAT
1	Arrival Time	1X,F15.4,1X
2	Job Name	F10.0,1X
3	CPU Time	F5.0,1X
4	Memory	F5.0,1X
5	Priority	F5.0,1X
6	Alloc. Devices	F5.0,1X
7	Cards	F6.0,1X
8	Lines	F6.0,1X
9	Disk Blocks	F6.0,1X
10	Alloc. Device Blocks	F6.0,1X
11	Job Type (Note 1)	F2.0,1X
12	CPU Time Used	F10.3,1X
13	I/O Time Used	F10.3,1X
14	Memory Size Used	F10.3,1X
15	Departure Time	F15.4

Note 1: ACTLOG only records user jobs so Job Type is always 1.0.

Table 7 SFTMON Record Format

FIELD	VARIABLE	FORMAT
1	Queue Name	1X,A15,1X
2	Time in Queue	F8.3,1X
3	Where Job Came From	A15,1X
4	Where Job is Going	A15

Table 8 HRDMON Record Format

FIELD	VARIABLE	FORMAT
1	Time of Recording	1X,F15.4,1X
2	Timer # 1	F8.3,1X
3	Timer # 2	F8.3,1X
4	Counter # 1	I5,1X
5	Counter # 2	I5,1X
5	Counter # 3	I5

Appendix F

CPESIM II

Student Manual

Contents

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List of Tables

CPESIM II
Student Manual

I. Introduction

CPESIM II consists of a simulation of a major computer system and its operating environment. It was designed for use as a laboratory aid to allow students to apply Computer Performance Evaluation (CPE) tools and techniques to a "real" computer system. The use of an actual system for such studies is impractical for several reasons. First, due to the overhead and disruption caused by some measurement tools, their use in a real system for classroom purposes may be prohibited by computer center personnel. Second, if measurement data is available it may not be academically useful. That is, the system may be operating as it should (thus providing no problem solving opportunities), or it may contain several interacting problems which, although realistic, cannot practically be resolved by a student as a one-quarter course project. Third, if the data does allow the student to analyze a problem and recommend a solution, it is unlikely that the computer center will allow the implementation of the solution (or of several conflicting solutions from several students). CPESIM II solves these constraints be providing a simulated environment in which the student can gather whatever data is desired, analyze the data and recommend a solution, implement the solution (at an appropriate cost), and then analyze the modified system to verify whether or not the solution was effective.

CPESIM II consists of two parts. The heart of CPESIM II is a computer simulation (written in SLAM) of a large-scale computer system processing a workload, which executes on a host machine (e.g., the CYBER). Because it is a simulation, there are many simplifications and limitations which restrict its representation of reality. The second part of CPESIM II is a simulated operating environment for the computer system. This includes a computer-generated workload, a written scenario, budgetary constraints, and system data in a form that can be manipulated and analyzed by the student, playing the part of a CPE analyst and/or DP manager.

The written scenario provides the student with operating details about the particular computer installation he or she is to investigate. The instructor configures the hardware, operating system, and workload to illustrate a particular problem or situation. Measurement data is then provided to the student as requested for analysis and decision making on a periodic basis (e.g., weekly). In order to force the student analyst to make tradeoffs, only a subset of the available data can be accessed during a given period, and an appropriate cost is associated with each student request.

CPESIM II Output To Students

Many types of information are available to the student to aid in the analysis. Some of these are free and automatic. Some must specifically be requested. There is a cost associated with many. Some are mutually exclusive. The student must choose what data he wants and how he wants to use it. This section briefly describes the outputs available and directs the student to further information.

Manufacturer's Data - Literature (of varying value) describing hardware and software features is available in printed form.

Installation Documentation - In-house documentation of the local configuration, parameter values, modifications, problems, etc., may be available in printed form. These are specific to a given problem and will be provided as a separate handout.

Accounting System Data - The computer's accounting system files are available at no cost to the student as disk files on the host computer. Such data is in raw form, and the format is defined in the manufacturer's literature for the appropriate operating system.

Hardware Monitor - A hardware monitor exists for the simulated computer. However, such a monitor may have to be purchased or leased. Particular probe points and sampling periods must be specified by the student. As with a real hardware monitor, there is no effect on system performance. The output data is available as a disk file on the host computer.

Software Monitor - A software monitor is available for the simulated computer. However, it may have to be purchased or leased. As with real software monitors, these monitors require memory, runtime, and other system overhead to operate. Output data is available as disk files on the host computer.

Budget Reports - Periodic written summaries of the dollars spent will be available to the analyst.

Student Inputs to CPESIM II

One of the advantages of a simulation is that the students can make changes to the system. Thus, there are a number of inputs that the student may (or must) provide to CPESIM II (as well as some that he cannot). This section briefly describes the CPESIM II inputs available to the student.

Workload - Students have no control over the workload. The instructor does control the workload and may choose to vary it as the situation dictates (e.g., in response to a student initiated "user education program").

Interview Requests - Student analysts can submit written questions to installation personnel. Questions may or may not be answered. Charges for personnel time spent answering questions will be assessed to the student's account.

Monitor Purchase - Student analysts can submit purchase orders for the purchase of lease of any available hardware or software monitors.

Monitor Input Parameters - If the software monitor is desired then the students must provide the simulation the starting time, stopping time, and the queues to be monitored. If the hardware monitor is chosen then the starting time, stopping time, sample rate, counter probes, and timer probes must be specified. The student can input these parameters by using the "User" interface while making the configuration file.

Reconfiguration Requests - Students may request reconfiguration of existing hardware and operating system parameters. Personnel costs to reconfigure will be assessed. Degradation of system performance because of such changes will be frowned upon by installation management.

Purchase of System Options - Additional hardware or operating system modules may be purchased by submitting an appropriate purchase order. Costs will be assessed directly to the student account. Information on current cost and availability will be provided with each particular project.

Personnel Hiring - Requests for hiring additional installation personnel (e.g., for an additional shift) or for overtime authorization may be submitted. If approved, costs will be assessed directly to the student account.

Student Input for Grading

Of course, choice of grading technique is the prerogative of each individual instructor. However, this section describes one set of student inputs that may be used for that purpose.

Final Report - This represents the single most important input to the student's final grade. The report should be typewritten with drawings, tables, and graphs of professional quality. The report should consist of two parts. Part 1 is the Analyst's Report. This should include a clear statement of the problem as perceived, a systems analysis and description, stated hypothesis of the specific problem, analysis done to confirm (or deny) the hypothesis, recommended solution, and verification that the implemented solution solved the problem. Also, included should be a cost analysis and recommendations for the future. Part II is the Student's Critique. This should include an evaluation of the simulation as a learning tool along with a discussion of problems encountered and recommended changes.

Interim Reports - Various interim reports may be required throughout the quarter, depending on the scenario. These should be of the same quality as the final report and will count toward the project grade.

Software Tools - Some specific software tools (e.g., data reduction packages) may be required during the quarter. These will specifically count toward the project grade. For any other tools that the student might develop, the source code should also be submitted. These programs will influence the project grade.

Oral Presentation - Each team will be required to make a final oral presentation to the class and possibly an interim report as well. Although an important purpose of the oral report is to share each team's analysis and findings with the rest of the class, presentation is a graded part of the project and should be done in a professional manner.

II. American Business Computer (ABC) BITBUCKET Computer System

Introduction to the ABC Computer

The ABC computer system was designed to provide flexiblity in providing custom computing power to any organization. This system consists of a variety of hardware and software options, which can be configured in many ways to tailor the BITBUCKET to the computing needs of the individual installation. This document provides abbreviated specifications of both the hardware components and the software options available to the ABC customer.

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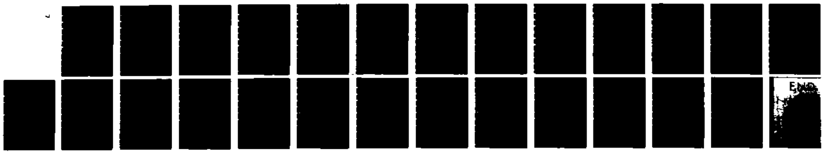

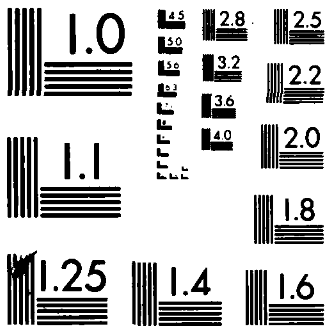
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5.0
5.6
6.3

Hardware Specifications

Model 2000 CPU

The Model 2000 represents ABC´s standard Central Processing Unit. The Model 2000 provides for an extensive instruction set, with an average execution speed of 4 microseconds per instruction.

Model 3000 CPU

The Model 3000 provides the same capabilities as the Model 2000 except for a faster speed. The Model 3000 average execution time is 3 microseconds.

Model 20 Core Memory

The primary main memory unit for the BITBUCKET system is the Model 20, 96K word module. This multi port memory allows connection to up to 5 IOCs and up to 99 CPUs. The module can be expanded to have a up to 20 partitions of 1000K words apiece.

Models 3110 and 3117 Input/Output Controllers

The ABC Input/Output Controllers (IOCs) are sophisticated I/O channels, each capable of interfacing several peripheral devices to main memory.

Model 3110 is a byte-multiplexed channel capable of multiplexing up to 10 devices, each with a maximum transfer rate of 2.5k bytes per second. The primary function of this channel is to provide an overlapped interface for the system´s card readers and line printers.

Model 3117 is a high speed multiplexor channel capable of multiplexing several block-oriented devices such as magnetic tapes, disks, and drums. Up to ten high speed devices can be connected to each 3177. Each device can transfer data at a rates up to 500K bytes/second. The channel itself is capable of transferring 500K bytes per second, and can multiplex the transfer of multiple blocks as long as the sum of the data rates of the devices concerned are within the transfer rate of the channel. This controller requires interconnection to an accessed disk or drum during speed and rotational latency. In the case of high speed drums (e.g. Model 2700) the controller is dedicated during the entire delay period. For the slower disks (e.g. Model 2714), the wait time can be multiplexed between several disks as long as the total transfer rate of the multiple disks is less than the maximum transfer rate of the IOC.

Model 2700 Drum

Fixed head per track

Rotational speed - 3600 rpm

Capacity - 7K per track

- 25 Active tracks

Transfer speed - 410K bytes/second

Model 2714 Disk

-Consists of a controller and one single-spindle disk drive, connects directly to IOC

-Data storage capacity of each drive is 20.48 million bytes

-Access arrangement: each drive provides access to 200 recording cylinders via a column-type access mechanism with 20 vertically aligned read/write heads, 1 per disk surface. Each cylinder position provides access to 102,400 bytes of storage.

-Disk pack: each drive accommodates one IBM 2316 or equivalent disk pack which contains 11 disks and provides 20 recording surfaces

-Head position time:

Track to Track - 30 ms

Average - 74 ms

Max - 156 ms

-Transfer rate: 312,000 bytes per second

-Rotational speed: 3600 rpm

Model 6051 Magnetic Tape Drive

The Model 6051 has been one of ABC´s standard workhorse models for many years. Although of lower density and slower speed than more recent entries, the 6051´s low cost and high reliability account for its continued popularity in many systems. Since the Model 6051 uses industry standard 9 track 1/2 inch magnetic tape, it utilizes the same physical medium as all other ABC tape drives, thus requiring an inventory stock of only one tape type.

-Tape: Standard 1/2-inch magnetic tape
2400-ft reels.

-Tracks : Nine-track

-Density: 800 bits-per-inch

-Encoding: NRZ

-Speed: 37.5 inch/sec

-Transfer rate: 30,000 bytes/sec

-Gap size: 0.5 inch between blocks

-Physical Dimensions: 19" x 48"

<u>Model 6110 Magnetic Tape Drive</u>

The Model 6110 is ABC´s standard high speed 9-track tape drive. The high transfer rate of 120,000 bytes per second combined with reliablity of 800 bpi density make the Model 6110 an effective tape storage drive. ABC´s patented Quicloc mechanism speeds tape mounting.

-Tape: Standard 1/2-inch magnetic tape
2400-ft reels.

-Tracks : Nine-track

-Density: 800 bits-per-inch

-Encoding: NRZ

-Speed: 150.0 inch/sec

-Transfer rate: 120,000 bytes/sec

-Gap size: 0.5 inch between blocks

-Physical Dimensions: 19" x 36"

Model 7001 Magnetic Tape Drive

The Model 7001 is ABC's top of the line high speed 9-track tape drive. Although actual effective data storage capacity depends on block size used, due to the need of a .4 inch interblock gap, the Model 7001 allows a capacity of 40 million bytes. ABC's patented Quicloc mechanism speeds tape mounting. The Model 7001 has proven itself as a highly reliable tape drive in many installions.

-Tape: Standard 1/2-inch magnetic tape
2400-ft reels.

-Tracks : Nine-track

-Density: 1600 bits-per-inch

-Encoding: NRZ

-Speed: 150.0 inch/sec

Transfer rate: 240,000 bytes/sec

-Gap size: 0.4 inch between blocks

-Physical Dimensions: 19" x 42"

Model 2920 Card Reader

Standard card reader reads industry standard 80 column cards. Read rate is 1000 cards per minute. The input rack holds 5000 cards.

Model 1200 Line Printer

Standard tractor-feed train line printer. Prints 1000, 132 character lines a minute.

SOFTWARE SPECIFICATION

There are two different operating systems that can be run on the ABC computer. These operating systems can handle either a single cpu configuration or a multiple cpu configuration.

Batch Uniprocessor Multi-Programming System (BUMPS)

BUMPs is ABC's multiprogramming operating system intended for use in a batch environment with a single processor. BUMP's comes as standard equipment for the ABC computer. This operating system is described in more detail in the following sections.

System Jobs

The BUMPs operating system consists of a nucleus which is core resident, requires 96K words, and includes such tasks as memory loading, input/output control, and processor scheduling. In addition there are three system programs which DO have impact on the flow of user programs. The Job Scheduler, although core resident (in the 96K nucleus), must go through the execute queue like any other job. The Input Spooler and the Output Spooler are not normally core resident and must acquire resources in the Hold queue like any other user job. The operation of these programs and the resources they require is described in greater detail below.

Job Flow

A typical user program gets into the system through the input spooler (Figure 1). After the job is spooled it is placed into the hold queue to await resources. The job scheduler examines the jobs in the hold queue, according to the job priorities and the time the job entered the hold queue, and allocates memory partitions and allocatable I/O devices to each job. After the job is allocated it proceeds to the execute queue. When the cpu is free it takes the highest ranking job in the execute queue and performs a cpu burst. Job ranking in the execute queue is done by job type. The job scheduler gets the highest priority, followed by the software monitor start-up job, output spooler, input spooler and user jobs, respectively. The cpu burst lasts until one of four things happen: an I/O was issued for an allocatable I/O device, an I/O was requested issued for an unallocatable device, a timeout occurred, or the job finished. If an allocatable device I/O request occurred then the job gets placed in the smallest channel queue which is connected to the requested I/O device. The I/O is performed, the channel is freed, and the job is placed back into the execute queue. If an unallocatable device I/O occurred the job gets placed in the proper device queue. Once the device has been acquired the job is placed in the smallest channel queue which is connected to the device.

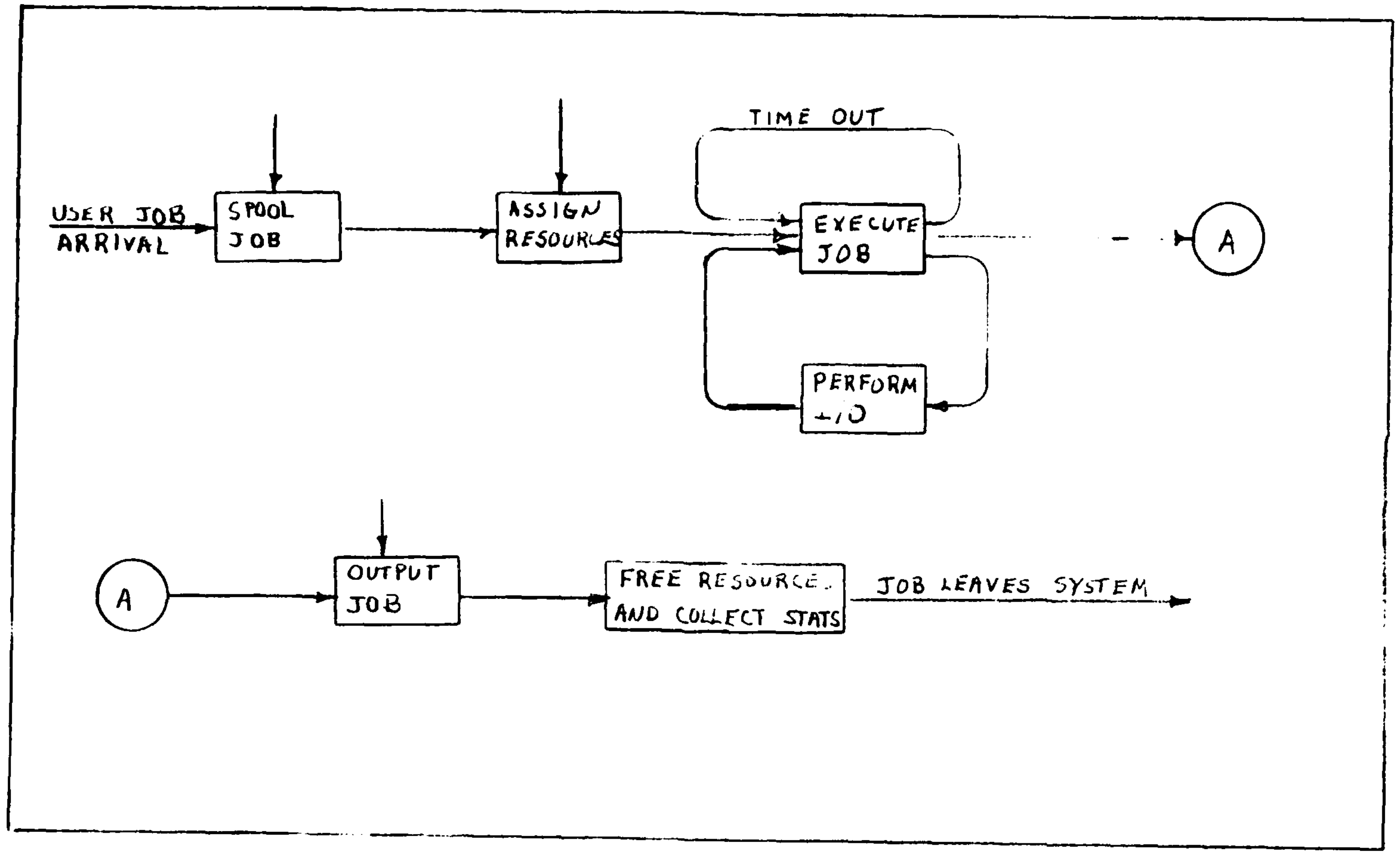

Fig 1. Typical Job Flow

The I/O is then performed. After completion of the I/O the channel and the device are freed and the job is placed back into the execute queue. If a timeout occurred then the job is placed back into the execute queue to wait for another time slice. If the job is completed the job is placed in the output queue and waits for the output spooler to print the job. Also at that time, the memory partition used and the allocatable devices assigned to the job are released back to the operating system.

Input Spooler

The input spooler takes the user's programs in the card reader and spools them onto the disk. When a new job arrives at the input queue the operating system checks to see if the input spooler is already in memory. If the spooler is not in memory it is placed in the hold queue and must compete for resources and cpu time like any other job. The input spooler requires a memory partition of 4K before proceeding to the execute queue. When the input spooler acquires the cpu, it first schedules an I/O to read the 80 byte cards into a 1K system buffer. After the buffer is loaded the spooler is placed back into the execute queue. The next time the spooler gets the cpu the buffer is spooled to the disk. This two step process continues until the entire job is spooled. At that time the operating system checks to see if there are any more jobs in the input queue.

The input spooler continues until all the jobs in the input queue are spooled. The input spooler is then released from the system and the memory partition is returned to the operating system. The input spooler requires .001 seconds of cpu time every time it acquires the cpu.

Output Spooler

The output spooler takes the job's output file which is stored on disk and prints it. Whenever a job arrives at the output queue, the operating system checks to see [illegible] the output spooler is loaded. If necessary the output spooler will be placed in the hold queue. It will wait for a memory partition of at least 4K before it will proceed to the execute queue. When the output spooler first executes it will perform an I/O which will load a 1K system buffer from the disk file. The spooler will be placed back into the execute queue so that it can print the buffer in the form of 132 byte lines. This process continues until the entire job has been printed. Like the input spooler, the output spooler continues to spool until its associated queue is empty. In order to set up a transfer, the output spooler consumes .001 seconds of cpu time every time it acquires the cpu.

Job Scheduler

The job scheduler allocates memory partitions and allocatable I/O devices (tapes) to jobs in the hold queue. The job scheduler is loaded in the execute queue (if it is not already) every time a new job arrives in the hold queue or when resources are freed (after each user's job, spooler or software monitor completion). The job scheduler is always core resident as part of the operating system and does not count against the multiprogramming level. When the job scheduler obtains the cpu, it looks at every job in the hold queue to see if it can assign resources. Resources are assigned to jobs according to a priority system. The job scheduler ranks the jobs according to the job's priority attribute. This attribute is part of the job's input parameters. If there is a tie, the jobs are arranged according to the hold queue arrival time. Each job in the hold queue is analyzed according to this priority scheme. The job scheduler first checks to see if a memory partition is free which can handle the job. If a memory partition is free the scheduler thens checks to see if there are enough allocatable I/O devices free. Only if both conditions are met, is the job assigned resources and taken from the hold queue and placed into the execute queue. The job scheduler requires 3 cpu seconds every time that it executes and no I/O time.

Static Partition Memory Management

With this memory manager, the user may specify up to 20 memory partitions of various size. Partitions are defined in terms of 1K work increments. The memory manager users a First Fit algorithm. When the job scheduler executes it starts with first free memory partition, checking to see if the job will fit. If necessary, the job scheduler will check all free memory partitions.

Process Scheduler

The process scheduler selects jobs from the execute queue for the cpu to perform a cpu burst. The process scheduler uses a priority round robin scheme. Jobs in the execute queue are ordered first by their job type and then by the time they entered the queue. The job scheduler has the highest priority, followed by the the software monitor start-up job, output spooler, input spooler and user jobs, respectively. When the cpu becomes free the process scheduler takes the highest priority, longest waiting job out of the execute queue. The job will execute until its time quantum is used up, a I/O was issued or the job completes. If a time out occurs the job will be placed back of the execute queue. If a I/O occurs before the time-out, the job will do the I/O then go to the back in the execute queue. The process scheduler is part of the operating system nucleus and consumes no visible resources.

I/O System

To facilitate I/O data flow, all data transfers are done in fixed 1K blocks. The high speed multiplexed ABC Input/Output Controllers (IOCs) allow concurrent block transfers to or from several devices if the sum of the device effective transfer rates is within the transfer rate capability of the IOC itself. Each I/O request results in the transfer of a block of data from the specified devices, even if only a small portion of the block is requested. In order to make such a transfer, both the device and the IOC must be available. When an I/O is issued, the job first acquires the appropriate I/O device. If the device is busy, it must wait in the device queue. The device queues use a FCFS algorithm. After the job seizes the device, it tries to allocate an IOC which is connected to the device. If all the IOCs are running at capacity, then the job will wait in the smallest of the channel queues. Only after the I/O device and the channel are free is the data transfer started. Where possible, the I/O scheduler tries to distribute usage across the system of disks and drums.

Each job can have 4 types of I/O. First it must read all of the spooled cards from the disk. It must write all output printer lines to the disk file (for latter transfer by the Output Spooler). In addition each job requires a number of tape I/Os and a number of disk/drum I/Os.

Batch Multiprocessor Multi-Programming System (BMMPS)

The BMMPS operating system is exactly like the BUMPS operating system, except for the multiple processors. BMMPS can have a maximum of 99 cpus connected at one time. There is still only one execute queue from which all the cpus acquire jobs to process. All the cpus in the system are the same and can process any job.

ACCOUNTING DATA

The ABC computer records accounting data on every user job that goes through the computer. The accounting file contains one record per job. The contents and the format of the accounting file (ACTLOG) is listed below in Table 1.

Table 1 ACTLOG Record Format

FIELD	VARIABLE	FORMAT
1	Arrival Time	1X,F15.4,1X
2	Job Name	F10.0,1X
3	CPU Time	F5.0,1X
4	Memory	F5.0,1X
5	Priority	F5.0,1X
6	Alloc. Devices	F5.0,1X
7	Cards	F6.0,1X
8	Lines	F6.0,1X
9	Disk Blocks	F6.0,1X
10	Alloc. Device Blocks	F6.0,1X
11	Job Type (Note 1)	F2.0,1X
12	CPU Time Used	F10.3,1X
13	I/O Time Used	F10.3,1X
14	Memory Size Used	F10.3,1X
15	Departure Time	F15.4

Note 1: ACTLOG only records user jobs so Job Type is always 1.0.

SOFTWARE MONITOR

The software monitor is like any other job in the ABC computer system. It is entered into the system and must compete for computer resources. The monitor is loaded into the hold queue at the user specified starting time. It sits in the hold queue until a partition of at least 4K is available. It is then placed in the execute queue until it can acquire the cpu. When the monitor acquires the cpu it starts the tracing of jobs through five user specified queues. The software monitor then releases the cpu back to the operating system. Once the trace has started the monitor will record data about every job that enters one of the five queues. The queue name, the time spent in the queue, where the job came from, and where the job is going, is recorded every time a job leaves a queue. When the software monitor is monitoring queues and recording data, it puts an extra burden on the system. The software monitor causes the cpu to run at 95% efficiency. When the scheduled stopping time of the monitor occurs, the memory partition is freed and the cpu goes back to running at full efficiency. The software monitor writes its data to a file called SFTMON which is available for post processing. The contents and format of the records are list in Table 2.

Table 2 SFTMON Record Format

FIELD	VARIABLE	FORMAT	COMMENTS
1	Queue Name	1X,A15,1X	See Note 1
2	Time in Queue	F8.3,1X	In seconds
3	Where Job Came From	A15,1X	See Note 1
4	Where Job is Going	A15	See Note 1

NOTE 1: See Table 3 for possible contents of these variables.

Table 3 Possible SFTMON Names

VARIABLE NAME	COMMENTS
JOB ARRIVAL	
INPUT QUEUE	
HOLD QUEUE	
EXEC QUEUE	
OUTPUT QUEUE	
ARVL SPOOL	Input Spooler arrival in system.
ARVL OSPOOL	Output Spooler arrival in system.
ARVL S/WMOM	S/W Monitor arrival in system.
ARVL JSCHED	Job Scheduler arrival in execute queue.
JOB FINISHED	Job Completed.
TAPE 1 QUEUE	
TAPE 2 QUEUE	
TAPE 3 QUEUE	
TAPE 4 QUEUE	
TAPE 5 QUEUE	
TAPE 6 QUEUE	
TAPE 7 QUEUE	
TAPE 8 QUEUE	
TAPE 9 QUEUE	
TAPE 10 QUEUE	
DISK 1 QUEUE	
DISK 2 QUEUE	
DISK 3 QUEUE	
DISK 4 QUEUE	
DISK 5 QUEUE	
DISK 6 QUEUE	
DISK 7 QUEUE	
DISK 8 QUEUE	
DISK 9 QUEUE	
DISK 10 QUEUE	
CHAN 1 QUEUE	Channel 1 Queue.
CHAN 2 QUEUE	
CHAN 3 QUEUE	
CHAN 4 QUEUE	
CHAN 5 QUEUE	
CPU	
GENERAL CHAN	Used only in "Where job is going", because channel # not determine yet.
SPOOL QUEUE	Input Spooler queue.
OSPOOL QUEUE	Output spooler queue.

HARDWARE MONITOR

Unlike the software monitor, the hardware monitor does not use up the ABC computer resources. The hardware monitor has its own timers, counters, and data recording devices. It is an event driven monitor which can be connected to any I/O device, channel, or cpu. The hardware monitor has two timer probes and three counter probes. These probes along with the starting time, the stopping time, and the sample data rate are specified in the configuration file. One limitation in the hardware monitor is that the monitor treats multiple cpus as one. The timer or counter connected to the cpus will be pulsed every time any cpu is activated. The output of the hardware monitor is written to a data file, called HRDMON, which is available for post processing. The record contents and format is listed in Table 4.

Table 4 HRDMON Record Format

FIELD	VARIABLE	FORMAT
1	Time of Recording	1X,F15.4,1X
2	Timer # 1	F8.3,1X
3	Timer # 2	F8.3,1X
4	Counter # 1	I5,1X
5	Counter # 2	I5,1X
6	Counter # 3	I5

III. Modifying the ABC Computer Configuration

The ABC computer can be modified to any legal configuration by using a simple question and answer program. This program will from the responses, generate a configuration file. This file is then used as input to the simulation.

Executing the Configuration Program

The execution of the configuration setup program is a simple four step process. By following these four steps the configuration file will be generated and automatically catalog as a permanent file.

```
Step 1  (sign on to the Cyber)
Step 2  ATTACH,PROCFIL,SETUP,ID=EE752
Step 3  BEGIN,SETUP
Step 4  (Answer questions as they appear
         on the screen)
```

Trouble Shooting

The generation of the configuration file should work under normal circumstances. If an error does occur it is probably one of three things:

1. Character variables have to be enclosed in a single quote (´). Make sure you answer ´Y´ or ´N´ when it is appropriate.

2. If you get an error that states that there is no room for the file called CONFIG, it means that you already have 5 copies of the file. Since the Cyber can only hold five copies at one time, you need to purge one of the files. After you have purged a copy of the CONFIG file, type "RETURN,SETUP,CONFIG,TYPES". You are now ready to start again.

3. The third possible error that might occur is if you get disconnected from the terminal while in the middle of the process. If this happens return all your files and start again. If you do not return the files then the procfil might abort because it will try to attach the files again.

VITA

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